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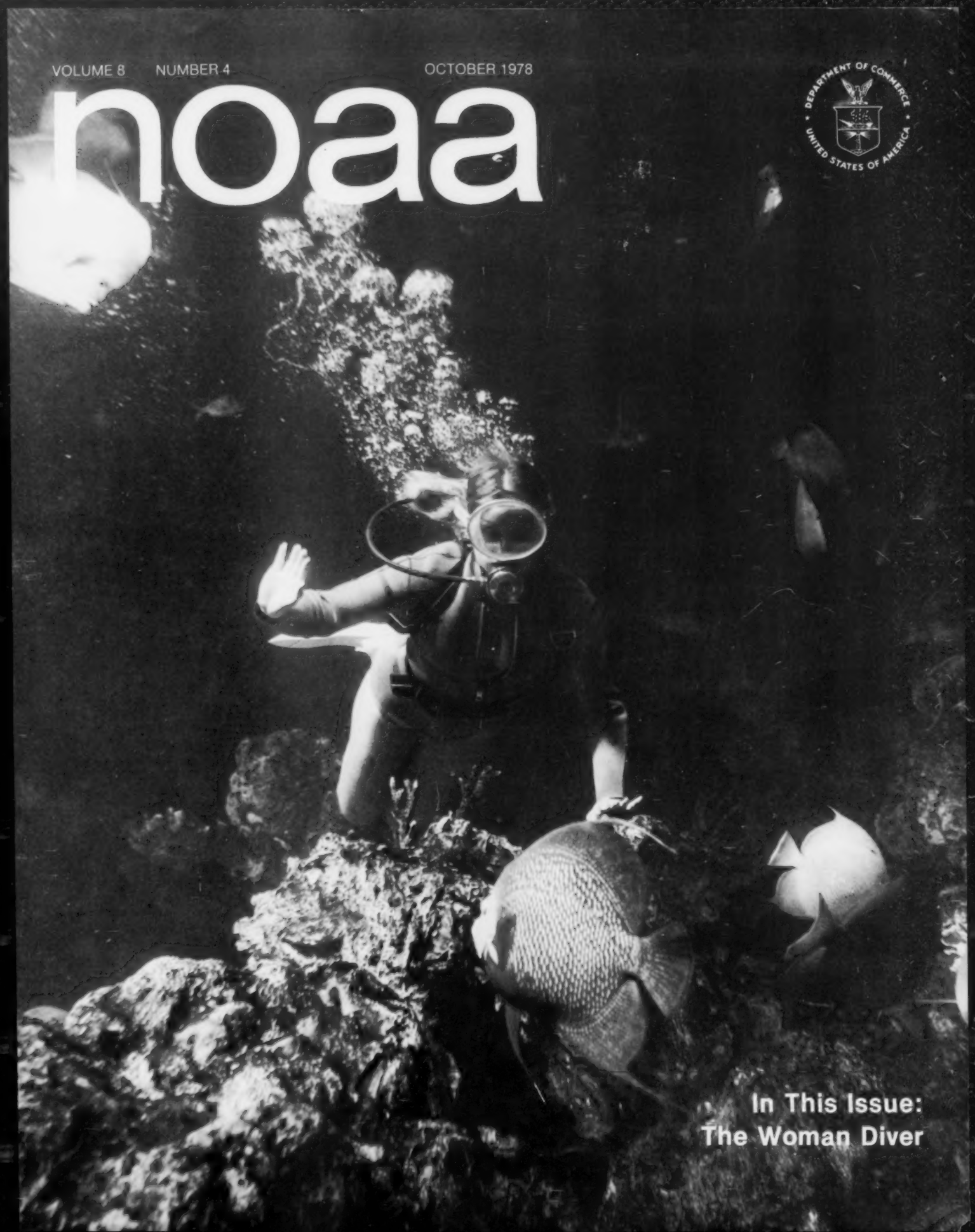

In This Issue:
The Woman Diver

VOLUME 8 NUMBER 4 OCTOBER 1978

noaa

Photo: Sea World

3 Reflections on Science—*by Dr. Ned Ostenso*

4 The Woman Diver—*by KC Smith*

10 NOAA's Ubiquitous Radio—*by Edwin P. Weigel*

16 **NOAA Profile:** Saving the Porpoise—*by Gerald D. Hill, Jr.*

20 Lengthening the Lifeline—*by Nancy Pridgeon*

23 Spotlight on the Magnetosphere—*by Cdr. Richard E. Newell*

28 In the Wake of the Ancient Mariner—*by Ann Greer*

32 Assignment: Fisheries

1. Hands-on Training for NOAA Corps Officers—*by John G. Stringer*
2. On Board at NMFS—*by Lt. Dane Voss*

40 Big Bird—*by Kurt Stehling*

42 **NOAA Profile:** Renewing Urban America—*by Valerie A. Gillen*

46 Dangerous Passage—The Columbia River Bar—*by Joan Vandiver Frisch*

50 NOAA Satellites: Working for You

52 View From Space

54 People and the Coast—*by Dallas Miner*

58 **Sea Fare:** Fun Food for Fall

60 NOAA/Update

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A Very Personal History

Reflections On Science

Mine has been a privileged life. Not by fortune of inheritance nor heritage. Rather, luck and good timing have positioned me to get a very personal view of recent science history.

To begin with, I had the good sense to be born at a time and in a place where the action was. There are more scientists living and working today than had existed *in toto* from the dawn of civilization to 1930—the year of my birth. When I entered college, 80 percent of the world's research and development was being done in the United States. Finally, I stumbled into fields that were truly pioneering and thus destined to throw open shutters to vistas of intellectual splendor rarely equaled. When I studied geophysics, my professors were inventing the field; when I taught oceanography, my students and I were inventing that field as we went along.

Allow me to give some vignettes from my personal experience that illustrate the social and intellectual changes that science has undergone over the past three decades—and then hazard some predictions. Many of you who read this have had similar experience which may or may not lead you to agree with my conclusions. Although I will argue for my position as being privileged, I do not, for a minute, believe it to be unique (except in detail) and my observations may be more provocative than profound.

When I was in college, my research grant constituted the use of my major professor's gasoline credit card, thanks to Dr. George Woollard's own munificence. It wasn't until the day before sailing for a year and a half tour in Antarctica that I learned I was actually going to get paid. Not only had I taken the term "volunteering" literally, but having the opportunity to do research was generally regarded as a privilege and not a source of income. For the most part, the equipment we had was what we made ourselves, from seismometers to magnetometers. I am not saying that those are the good old days, albeit the memories are fond. Today's reasonable compensation to the researcher plus his supporting infrastructure of technicians, laboratories, computers, etc., is the proper and necessary direction of social evolution reflecting society's expectations from the scientific milieu.

Discovery that the Antarctic ice cap was kilometers thick, rather than tens or hundreds of meters as commonly believed, drastically revised concepts of the global water budget with profound environmental implications. I still proudly hold title to the world's thickest ice sounding of 4,270 meters. The discovery was sufficiently startling that when we finally arrived at Byrd Station and radioed our findings back to the Academy of Sciences, the message was believed to have been a garbled transmission.

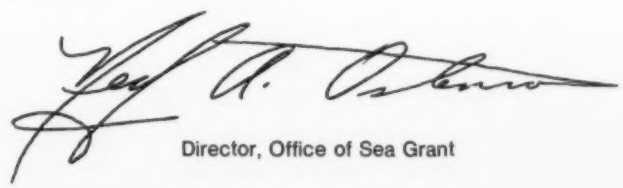
Years later, I was able to participate in oceanographic research that contributed to true revolution in the earth sciences—seafloor spreading. This new unifying concept of global tectonics ranks with the discovery of the first order. Still later I was involved (although this time not as a practicing scientist) in the excitement of discovering the eddy structure of the oceans. Surface and subsurface currents that were regarded to be *the* dynamics of the oceans are now known to represent only about 1 percent of the kinetic energy of ocean motion. A few years ago the remaining 99 percent was found to be bound in still poorly understood eddy structure which hold many analogies with atmospheric weather systems. During brief stints in the Executive Office and the Legislative Branch, I was able to champion for earthquake prediction and climatic forecasting, exciting nascent areas of research. So, in a variety of roles, I have had the privilege of being a witness to, and participant in, a truly exciting parade of progress.

Where does this parade lead us?

Intellectually, the most profound change I sense is in the increasing number of areas where the traditional buffering between basic research and societal impact no longer exists. High-energy and solid-state physicists did not build nuclear weapons and guidance systems. There were numerous linkages of applied research and engineering between discovery and, say, the bomb vs. the electrical generator. In an awesome number of new research areas, such intermediate linkages no longer exist. Recombinant DNA and genetic engineering, earthquake prediction, weather modification and climate forecasting are but a few examples. These pose whole new dimensions of direct social impacts on science unknown since the Dark Ages. For the first time in modern history, serious consideration is given to the limits of research!

Not only science but the scientists have been profoundly affected by recent history. Prior to World War II the scientist was traditionally viewed to be an eccentric but largely benign being. They didn't cost much to keep around and occasionally they did some good. The successful marshalling of talent to support the war effort, followed a decade later by Sputnik, cast the scientist into the unwarranted role of something of a savant—nine-out-of-ten told you what cigarette to smoke. Then came the mid-60's and the pollution and clutter of "progress" and an unwanted renegade war in Asia that touted some of the most sinister fruits of sciences for all the world to rebel at. Not only were the savant's feet of clay, but indeed he may be satan reincarnate—nine-out-of-ten now told you of the cardiovascular and respiratory horrors of smoking cigarettes. Both the savant and satan views of science are, of course, both unreal and unsustainable. We can hope the pendulum will swing no more and the scientist will find a responsible place in a responsive society. This relationship must be one of a journeyman among journeymen. It will impose, in addition to a heightened accountability for their actions, a largely unfamiliar accountability for science's well being.

Finally, I foresee a reversal of the trend toward the institutionalization of science. Universities will draw their fragmented parts back together into the wholistic intellectual enterprises they once strove for. The direction of the scientific enterprise will trend more toward a collegium of doers, supporters and the expectant (or impacted) public than toward further centralization of authority in the Federal Government. State and local governments will assume large roles in the scientific apparatus. Because the Sea Grant Program, to a large extent, is the embodiment of these trends, I find it a particularly exciting place to be in yet another great experiment.



Director, Office of Sea Grant

The Woman Diver

By KC SMITH

SKIN AND COMPRESSED AIR DIVING are not among the activities whose early histories were augmented greatly by women. Artistic depictions and the historical record suggest that men have been snooping around underwater in crazy apparatus for 2000 years; with the exception of the Ama women of Japan, who have been free diving for at least that long, it was the mid-1930's before diving was popularized in a form that reached women.

Men, by this time, were well ensconced in diving activities for salvage, military and commercial ventures. Their equipment was still cumbersome and crude, although many of the technical problems would be rectified within a decade with the invention of the aqualung. However, in 1936, when a newly developed, lightweight diving helmet became a seaside rental attraction, women were able to don the device and take a submarine stroll. These initial experiences were the beginning of an involvement which is now world wide.

European women generally led American women into the sea because much of the technical research in diving was being done in Europe; equipment and supervision were more readily available. Serious involvement for women in this country really began in the 1950's, and over the last 25 years, women have become active, enthusiastic participants in the development of diving as a cooperative rather than competitive activity. Although they represent only 25 percent of the U.S. diving population, women divers are increasing their ranks annually by about 20 percent. In 1976, the number of certified female sportdivers, instructors, research, and commercial divers was estimated at about 40,000.

This substantial membership in the diving community has brought to the fore questions and problems concerning female divers which previously had not been considered. A predominant mechanical problem, for example, has concerned the availability of comfortable and safe gear, which traditionally has been designed for a hefty male physique. Questions about physiological affects are being posed by women who want to know about their bodies and who want to feel comfortable to dive at any time: "Why do I stay so warm underwater while my buddy gets so cold?" "Can I go diving during my period?" "What happens if I dive while I'm pregnant?"

Many researchers, doctors, divers, and organizations are investigating or promoting education about women in diving. The four major certifying agencies have sponsored public seminars on the topic, encouraged their instructors to include pertinent information in training sessions, encouraged scuba shops to carry gear designed for smaller divers, and supported individual women researchers investigating female-related aspects of the activity.

The U.S. Navy and Air Force have observed the effects on women of hyperbaric and hypobaric environments, which yield similar physiologic problems, and the commercial industry now includes about 50 women who are doing hard hat or saturation diving as a profession. NOAA's Sea Grant College Program is among the federal groups that provide support for research in the field. Of 22 projects currently funded related to diving, several are related specifically to women divers.

Five studies in particular have laid the groundwork for an understanding of the modern woman and the effects the activity can have on her body. While one of the projects has yielded a description of the kind of female, in one region of the country, who engages in scuba, the other four have explored the physiological ramifications, particularly in regard to pregnancy.

The preliminary results of a Michigan Sea Grant-funded project on women divers recently were completely by Dr. Elleanor Crown at Wayne State University. Using questionnaires distributed through dive shops to determine demographic, financial, attitudinal, and practical information about women divers, the completed study, says Crown, "is intended to provide an idea of who the diving woman is, what kinds of diving she does, what she wants from the diving industry, and how she feels about her participation in this sport."

Although her current findings are based on only the first 69 questionnaires returned, Crown says she does not expect significant variations when all of the surveys are evaluated. Her primary survey area included Michigan and Ohio, with scattered surveys received from several southern states. The data indicate that female divers generally are married, have no children, have some college education, average three years of diving experience, come from families in which there are two or more divers, spend 20 days a year in scuba activities including six diving trips a year, and would not give up diving for any reason.

Until the relatively recent perfection of the lightweight aqualung, diving gear was designed for the hefty male physique.

One of the most important things her study has pinpointed, she states, is the lack of popular understanding and, consequently, of instruction, about the aspects of diving

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**KC Smith is a writer-editor wth the Texas A&M University Sea Grant College Program. She is also a licensed scuba instructor.*

Photo: Sea World

related specifically to females.

"The most significant things I've discovered are that female physiology is not taught in basic scuba courses, that women divers don't consult physicians for advice and information, and that they tend to make hard and fast decisions about female-related matters on their own. Basically, they have no guidance.

"To me, the fact that women are making decisions about diving during menstruation, pregnancy, or while taking birth control pills or other medication, without expert opinion, is really scary," says Crown.

As a result of her preliminary study, Crown, who is a certified scuba instructor, says she already has identified several areas where communication or investigation of female-related conditions should be improved. The diving industry should be encouraged to provide safe, suitable equipment for women and to improve their image in advertising, says the researcher. Physicians and physiologists should be urged to study diving problems associated with menstruation, pregnancy, oral contraceptives and menopause, and to determine whether U.S. Navy dive tables can be used safely by women.

Another group that can contribute to improving the quality of diving for women, says Crown, is scuba instructors. She believes they should be sensitive to all their students and try to reduce the anxiety many women students experience during a course because of male-biased training in the water and classroom. She says the example of one male instructor, who does not discuss menstruation and pregnancy in classes because "abnormal physiology" is not part of his curriculum, illustrates an attitude that is not uncommon and that must be changed.

"Diving is a physical activity and all relevant physical matters should be treated in a straightforward manner as part of diving physiology," states Crown.

In the absence of information related specifically to women, some of the data derived from diving research with males can be extrapolated to females, since every scuba diver is subject to the effects of water pressure, changes in gas tensions in the body, marine organisms, and the dependence on equipment for support. Most mechanical problems associated with these underwater conditions can be allayed by good training, education, and safe diving practices. Some of the physiologic ramifications, however, are more subtle and unpredictable because they depend on individual variations in sex, weight, age, and physical condition of the diver. In addition, there are particularities of the female body—the most obvious being pregnancy—that now demand some specialized investigation and consideration.

A pregnant woman experiences many physiological and hormonal changes that may yield symptoms that make diving less safe, or at least less comfortable. However, because a considerable number of women dive regularly, it is inevitable that some knowingly or unknowingly will dive while they are pregnant. Physiologists have identified several potential effects diving could have on a mother and fetus, and the primary medical concern is with a possible increased susceptibility in either to decompression sickness.

A serious diving complication under any circumstance, decompression sickness—the bends—can manifest itself as mildly as unusual fatigue, itch or rash, pain in the joints and muscles (Type I); or can produce the critical neurocirculatory reactions of paralysis, shock, unconsciousness, or death (Type II). Both types occur during or after ascent when nitrogen gas dissolved in the tissues creates bubbles due to a decrease in surrounding pressure.

As the diver descends, the increasing water pressure forces higher-than-normal levels of nitrogen into solution in the tissues. The rate at which this happens depends on depth, time at depth, water temperature, and variations in tissue physiology.

When a diver ascends, nitrogen levels return to surface values by coming out of solution and being vented off by respiration. If the ascent is too rapid for the blood to carry excess nitrogen to the lungs, bubbles can form and grow in critical areas of the body, affecting the central nervous, respiratory, or circulatory systems. A popular analogy is the opening of a soda bottle: when the pressure is released, gas comes out of solution in bubbles.

The malady is prevented by a controlled, gradual ascent to the surface, or by observing "no-compression limits" suggested in the U.S. Navy dive tables. These are the times a diver can spend at various depths with little risk of developing the symptoms of bends during or after ascent.

Physiologists are concerned that critical tissues in the mother and fetus may not function efficiently enough in venting nitrogen to prevent the development of bubbles in tissues or circulating in the bloodstream. Until recently, the only two clinical studies (McIver, 1968; Chen, 1974) of decompression sickness in pregnant dogs and rats indicated that a mother is more susceptible to the acute forms of the malady than her fetus. However, a Sea Grant-funded study completed this spring at Texas A&M University has yielded opposite findings, as well as some additional sobering information, and may provide a preliminary answer about whether pregnant women should scuba dive.

In research conducted by graduate student Clifford Simmang, under the direction of Texas A&M physiologist Dr. William Fife, the fetuses in sheep exposed to various time and depth diving profiles in a hyperbaric chamber showed a greater susceptibility to decompression sickness at deep depths than their mothers. Fife suggests that the similiarity of placental blood flow in women and ewes may provide a basis for extrapolating the sheep research to humans. Although there are gross anatomical differences among all the pregnant animals used in previous decompression sickness studies, dogs and rats have a "countercurrent type" blood flow between the maternal and fetal

Photo: Sea World

circulation, a relationship which Fife says is more efficient in moving gas out of fetal and placental tissues. Humans and sheep do not have this countercurrent system.

According to Fife, the data imply that a pregnant scuba diver could harm her unborn child, perhaps fatally, on certain deeper dives, and may even threaten its wellbeing during shallow, short exposure.

"Our findings have shown that in sheep even a standard no-decompression dive to depths over 80 feet presents risks to the unborn infant," says Fife.

"Because previous studies have indicated that sheep are more bends-resistant than humans and should be able to tolerate more severe decompression, it may be that dives by a pregnant woman to even shallower depths could be dangerous."

In every instance where potentially fatal symptoms were detected in the infant, no symptoms were identified in the ewe.

The data are based on 17 tests on seven ewes which were compressed in a hyperbaric chamber at a desired time and depth, then returned directly to surface pressure without "decompression stops," which provide gas venting time during ascent. The time and depth dive profiles ranged from extreme exposures—160 feet for 20 minutes—to shallow, no decompression dives—40 feet for 200 minutes.

The fetuses developed bubbles in every dive deeper than 100 feet. Six out of nine dives to 100 feet—including one for the standard 25-minute no-decompression limit—"caused bubbles in fetal circulation so massive that they most certainly would have resulted in death if treatment had not been initiated," Fife states. A no-decompression dive to 80 feet for 40 minutes produced only occasional bubbles in the fetus, as did a dive to 60 feet for 90 minutes—one-and-a-half times the no-decompression limit. Neither of these cases required treatment. Three less extreme exposures yielded no detectable fetal bubbles.

Although these tests imply greater infant susceptibility to bends at deeper depths, Simmang says the most important point is that on none of the dives did the mother develop detectable intravascular bubbles, a

symptom of the more critical forms of decompression sickness.

In addition, Fife suggests that a fetus may act like a "slow tissue"—one which takes up inert gas (primarily nitrogen) more rapidly than it is eliminated. If this were aggravated by the absence of an efficient gas transport system, bubbles could form and be held in fetal tissues.

In such a case, says Fife, "the fetus probably would be less vulnerable to decompression sickness on short, bounce dives (where less nitrogen is driven into tissues) than on a long dive in which the inert gas driving force and the exposure time would result in an increase of the gas load in the fetus."

Both Fife and Simmang acknowledge that their findings are preliminary, and stress that some of the differences in placental structure between humans and ewes introduce an unstudied factor which may also affect gas transport. Additional research will be required to determine more precise information.

"We have only preliminary information about fetal susceptibility in sheep to decompression sickness in the 80- to 100-foot range, and we have not determined the bends threshold at 60 feet and above," says Fife. "We have not yet clearly determined the similarities between the sheep and human fetuses, or the possible degree of increased susceptibility of the human fetus over the sheep fetus. We also do not know if the age of the fetus has a bearing on the matter. Until we find out these things, I think that a pregnant woman should not dive."

The problem of decompression sickness in pregnant divers is receiving statistical as well as clinical study because of another Sea Grant-funded project being conducted by graduate nursing student/diver Margie Bolton. Working at the University of Florida at Gainesville under the direction of Dr. Molly Dougherty, Bolton is conducting an international survey of female divers who have been pregnant during the last five years. She intends to compare the frequency of pre- or post-natal complications between women who dived while pregnant and women who dove prior to but not during pregnancy.

Although she is interested in any complications reported by survey respondents, Bolton has identified six primary problems she expects to see if serious complications are associated with diving during pregnancy. These include neonatal death (infant death within 28 days of birth), still birth, miscarriage, vaginal bleeding during pregnancy, birth defects, and prematurity (birth weight under 2500 grams).

In describing the frequency and nature of complications reported by pregnant divers, Bolton intends to assess the extent to which women continue the activity throughout their term, what advice they receive from their doctors, and how long and how deep they dive. She says she is particularly interested in cases where women made decompresson dives during their nine-month term.

Using a questionnaire to gather her data, Bolton has completed a pretest of 45 women to provide an early assessment of the situation and to test her questionnaire prior to a larger distributon that began in June. Analysis of the limited study, she says, has provided some interesting initial data. Dividing her respondents into two groups of women who did and did not dive during pregnancy, Bolton evaluated the females for their likelihood to develop complications based on their medical and obstetric histories. They were assessed as being either high- or low-risk pregnant divers.

Among 26 pregnancies during which women dived, the 22 women who were low-risk divers had none of the specific complications listed; among four high risk divers, one had a complication—a prematurity. Seven women reported diving prior to but not during pregnancy; all were low-risk divers, and only one experienced a problem, a miscarriage.

Bolton's interest in the problem stems from personal experience. When she was pregnant, she could not find any information about the safety or wisdom of diving during her term. Although several doctors gave her different opinions, she continued the activity until the seventh month. Most pregnant women, she says, finally stop diving because they "outgrow" the wetsuit they need to wear for warmth and protection. Women with advanced training—scuba instructors, for example—tend to dive longer into their pregnancy.

In a sample of 36 pregnancies involving 34 women (two reported multiple pregnancies) who dove while carrying a child, nine took their last dive during the first trimester, 17 during the second trimester and eight during the third trimester. Two women reported diving throughout the entire nine-month gestation period. Among those women who dove during pregnancy, generally as gestation increased, the frequency decreased, says Bolton, although the depths to which they dove did not decrease.

Among 34 respondents who reported diving while pregnant, 18 (53 percent) had doctors who said it would be okay to continue the activity; among seven women who didn't dive during pregnancy, all reported unfavorable advice from their physicians.

"These figures are interesting because generally we've believed that doctors tell their patients to stop diving as soon as they discover they're pregnant. This may not be the case," says Bolton. "It also indicates that some women stop simply because their doctors tell them to."

Bolton can be contacted about participation in her survey at 3311 N.W. 30th Avenue, Gainesville, Fla. 32605.

In addition to the possibility of increased bends susceptibility in the fetus or other complications of nativity, another potential pregnancy-related problem for women divers has been identified: the effects of a high partial pressure of oxygen in the body. At the surface, oxygen constitutes about 20 percent—.2 atmospheres—of the breathing mixture; at 132 feet—five atmospheres of pressure—its partial pressure in the body is about 1.0 atmosphere, which is equivalent to breathing pure oxygen at sea level.

High percentages of oxygen or oxygen at high pressures are toxic, and among other problems are known to produce retrolental fibroplasia, which can result in blindness in some babies, although there is no evidence that this has occurred in diving. In most animal studies of the problem, fetal oxygen content under pressure remained relatively stable; however, humans have not been studied nor have the effects of minor increases

Photo: Sea World

in fetal oxygen partial pressure.

There is some professional concern about the toxic effects of the gas at depth; however, of greater concern is the fact that hyperbaric oxygen is an integral part of recompression therapy, the treatment for decompression sickness. At the present, there is little scientific information pertinent to women about the actual seriousness of this situation.

Because the occurrence of decompression sickness is related to a reduction of ambient pressure on the body, its effects also have been observed in the context of aerospace operations. The condition is caused by a rapid ascent to high altitudes and the resulting exposure to rapidly lowered air pressure.

At the School of Aerospace Medicine at Brooks Air Force Base, San Antonio, Texas, Dr. Bruce Bassett has examined the susceptibility to decompression sickness in nonpregnant females, primarily those participating in flight nurse training. His study is of interest not only because of the increased number of women joining military and commercial flight programs, but also because of the recent entry of women into the space program.

Bassett's 5-year survey (1968-72) of United States Air Force incidence of decompression sickness during altitude chamber training flights revealed 17 bends cases that required hyperbaric treatment (treatment in a recompression chamber). Eight of these cases (47 percent) occurred in women. Although this seems like a statistically small number compared to the average during this period of 58,000 trainees annually, it represents a tenfold greater incidence of decompression sickness in women than in men.

In his study report, Bassett notes: "The proportion of females receiving (altitude chamber) training is small; therefore, the incidence of altitude decompression sickness in females appears to be far greater than in males."

Bassett's further analysis revealed that delayed onset of bends was more common in females, as was the occurrence of cases which required additional or extended hyperbaric treatment. Women also tended to have a more complex pattern of effects. Because his analysis of exposure and individual factors showed no significant differences other than sex, Bassett suggests the apparent susceptibility of individuals or groups might accurately be ascribed to differences in their response to bubbles formed during decompression as opposed to differences in their likelihood to form bubbles; however, Bassett notes that laboratory studies would be required to confirm this hypothesis.

Although susceptibility to decompression sickness or other deleterious effects of diving during pregnancy are serious considerations, they are not the only personal problems a female diver can experience. Dr. Susan Bangasser, a biochemist and scuba instructor affiliated with the National Association of Underwater Instructors (NAUI) in California, has reported several additional physiological areas of concern to women, including thermal comfort, diving during the menstrual period, and diving while using birth control pills.

Women have different sensitivities to hot and cold than do men. Although women have a layer of subcutaneous fat that, because of its low thermal conductivity, tends to retain body heat, Bangasser says her experience as an instructor has been that women chill in the water sooner than men. The reason, she suggests, is related to the degree of body fatness and the ratio of surface area to body mass.

"Lean women (less than 27 percent body fat) have a large surface area to body mass ratio, and therefore cool at a faster rate," says Bangasser.

The same body fat causes a woman's body temperature to rise two to three degrees higher than a man's before she starts sweating to cool off. In addition, a female has fewer functional sweat glands in her body. These two factors can affect a woman's comfort in warmer air or water temperatures.

Whether a woman should dive during menstruation depends primarily on how she feels, says Bangasser. Many women experience abdominal cramps, nausea or unusual fatigue during their period, symptoms which rightfully should inhibit diving at any time of the month. The tendency toward fluid retention in the body during menstruation might be a concern, says the researcher, since edema has been associated with women's sensitivity to decompression sickness. Bangasser advises that "females should follow conservatively the no-decompression limits of the U.S. Navy dive tables if diving three days prior to or during their period."

She makes the same suggestion about conservative diving to females who take birth control pills, which have been implicated as a factor in the increased risk of decompression sickness. She also adds that deep and decompression dives should be avoided.

Bangasser currently is evaluating the data from 700 questionnaires she has received in her study of medical aspects of women divers. Among the information which respondents were asked to complete were questions about diving during menstruation and while using birth control pills; decompression dives taken during a period, pregnancy or the use of oral contraceptives; the effects of diving during these circumstances; and the incidence of decompression sickness among women divers. She intends to publish her final data in a diving magazine.

One surely wonders, after reading about some of the pitfalls that await women who don scuba and descend, why any consider doing diving in the first place.

There are answers to this as unique to women as the problems they face. Aside from personal curiosity or enjoyment for the sport, many women begin diving at the encouragement of diving boyfriends and husbands who are looking for an activity to share. For some women the desire to compete on a par with men has stimulated an interest and sense of challenge. Women who have entered marine scientific disciplines have found diving a necessity to conduct their research, and some women take up the activity because of an athletic enjoyment for the sport.

However, the most accurate reason for women becoming involved is that there now is a place for professional women divers in the field, and there exist professional women divers who have something important to contribute. Today women are augmenting and complementing the diving industry, and are receiving support from other divers, male and female.

Nonetheless, the unique potential problems that a woman may encounter during scuba diving must be addressed on a scientific and personal level. While the former awaits funding and impetus, the latter can be assisted by what seems to be a consensus among diving researchers of practical steps a woman can observe.

All divers, men and women, should be aware of their physical well-being at all times and only dive if they feel able and comfortable; a woman diver should exercise extra caution immediately prior to and during her period and dive well within the no-decompression limits suggested by the U.S. Navy tables.

Even more conservative attention should be placed on diving during pregnancy. While no data exist which prove that a pregnant woman should stop the activity entirely, there are sufficient potential hazards that she should consider carefully, and with professional guidance, any decision to continue.

Women with any gynecological or obstetric peculiarity in their medical history should seek professional advice about whether the previous situation could affect their health if they dive.

The best prevention of diving-related problems is knowledge, training, and safe diving practices. Men and women who are informed about the effects of diving on their bodies and who use equipment tailored to their body shape and size relieve two sources of diving stress. They become more confident and competent divers, and in the long run, make a beneficial contribution to the safety of the activity. □

Have your forecast wherever you go

NOAA's Ubiquitous Radio

By EDWIN P. WEIGEL

NOAA WEATHER RADIO is succeeding far beyond its founders' fondest expectations.

This system of continuous broadcasts of storm warnings and weather observations and forecasts was begun back in the 1960's to serve recreational boaters. Since then, it has been expanded to cover just about everyone.

Already there are more than 225 stations, operated by the National Weather Service, and the pace of installations is accelerating, because people like it so much. When completed next year, there will be about 340 stations, covering 90 percent of the U.S. population.

This letter from Neal J. Whyte, a businessman in Pinconning Mich., illustrates the type of response that has been flowing into National Weather Service officers all over the country.

Mr. Whyte wrote to the National Weather Service Office in Flint, Mich.:

"You people are doing a fantastic job, (providing) an invaluable service to such industries as farming, commercial fishing, and construction. The list is almost endless. It should save them fortunes.

"I use it for pure enjoyment and for planning my days three days in advance. (I have) nothing but admiration for the professional status of you people. I, for one, will gladly accept any additional increase in taxes to insure its continuation.

"Congratulations. You are just great."

Mr. Whyte added as an afterthought that he has three sets with which to tune in the broadcasts—one at home, one at the office, and a small pocket portable that he carries with him.

A Nebraska weekly newspaper editorialized: NOAA Weather Radio "is probably one of the most beneficial systems that the Government has devised for the taxpayer. Yet too many of us don't take advantage of the protection the system provides."

Further proof of NOAA Weather Radio's popularity is that, as word has spread, a great many States have volunteered to provide facilities, and in some cases staff to augment and speed its availability.

Earl Estelle, program leader for NOAA Weather Radio, wrote recently: "This is one of the hottest things we've ever had going for us. We currently have about 35 States and Puerto Rico cooperating in completing the system. Clearly, they think the system is worthwhile, or they wouldn't be helping us. User surveys by individual Weather Radio stations produce hundreds of letters, almost all highly favorable. A voluntary response of this magnitude is extraordinary. Some of our stations get Christmas cards from listeners.

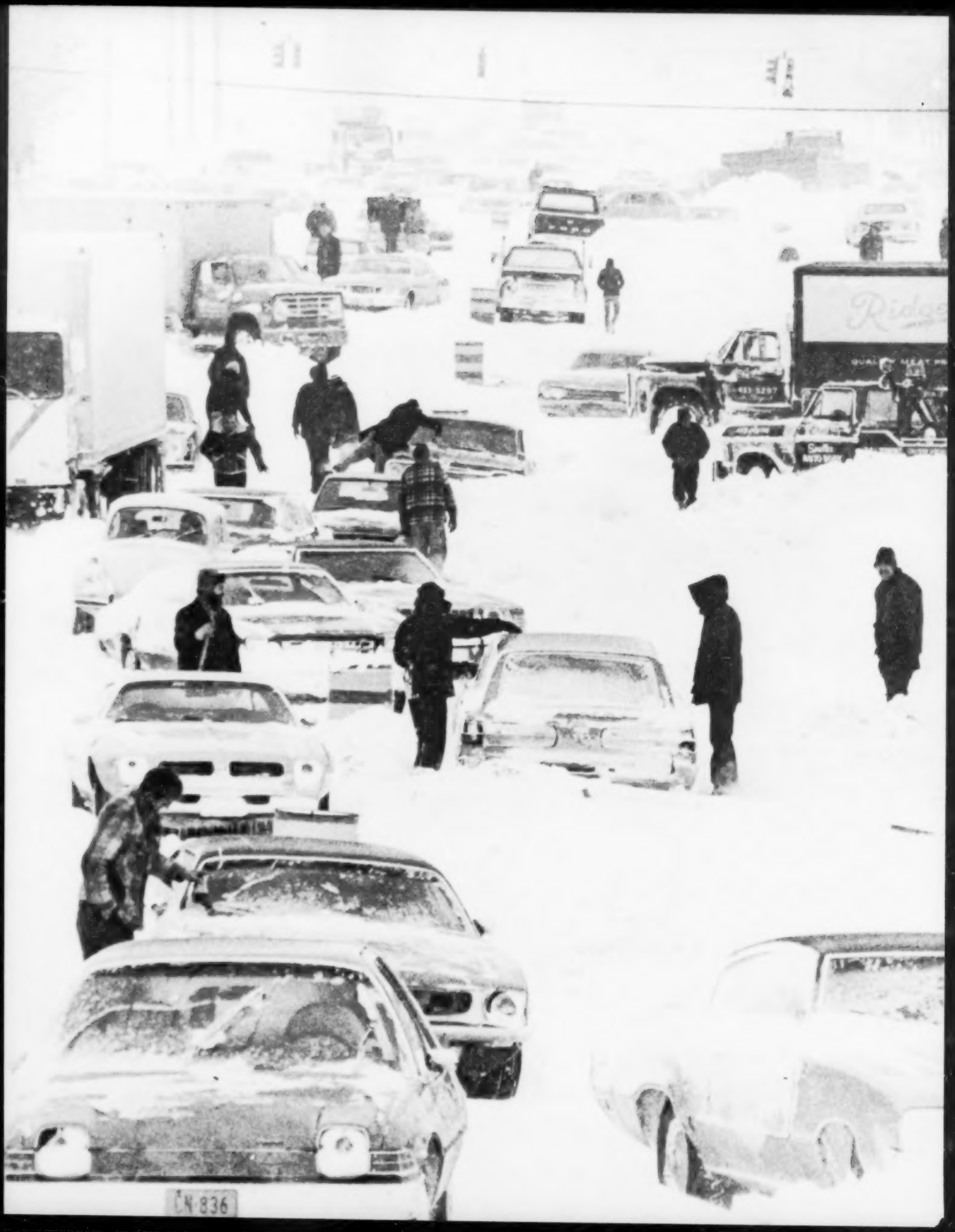
Charna Lester monitors operations of the NOAA Weather Radio at the Washington, D.C., Weather Service Forecast Office. The station is one of more than 225 in the fast-growing network.

"Manufacturers are equally enthusiastic. One firm has sold more than 1.4 million receivers capable of picking up the broadcast. A randomly selected retailer in Little Rock told me that Weather Radio receivers were the hottest item in his store, now that the CB rage has passed. Another manufacturer is unable to keep up with customer demand. His last production run increased sixfold over the previous one.

"The Kentucky network, the first one to go in under a cooperative Federal/State agreement two years ago, is getting remarkable results. The meteorologist in charge at Louisville estimates there is at least one Weather Radio for every eight Kentucky families.

"Mansfield, Ohio, wants to donate a total system for us to operate. Several other cities have already done so. South Carolina is working on a bill to provide receivers for every school in the State. Many school districts in other States have already done so.

"Arkansas, Tennessee and Mississippi have passed legislation providing for expanded networks beyond the Federal plan. Other States, for example, Minnesota and Wisconsin, are considering similar action."



In Estelle's view, testimonials, such as these, bear the same authority as a popular referendum—people voting for a program with their dollars—and the response is snowballing.

For members of the NOAA family unfamiliar with NOAA Weather Radio, here's how it works: The latest observations and forecasts are tape-recorded by local Weather Service offices in messages that last from three to five minutes. These messages are replayed continually, guaranteeing reception anv time of the day or night at the push of a button or the twist of a dial.

The tape-recorded messages are revised every three to four hours, more frequently when appropriate. When severe weather threatens, forecasters at the local Weather Service office interrupt the broadcasts with storm warnings, either tape-recorded or "live" as the situation demands.

Furthermore, the system has a feature which allows you to be alerted automatically, if you choose, when dangerous weather, such as a tornado or flash flood, is on the way. Radio receivers available for as little as $35 will silently monitor the NOAA weather broadcasts and automatically either sound a siren or come up to audible volume when the forecaster presses a button in his office signifying that a storm bulletin is forthcoming. These "warning-alarm receivers" are especially valuable for schools, hospitals, nursing homes, factories, mobile-home communities and other places where large numbers of people are congregated. They are also of vital importance to radio and TV stations and public-safety officials.

Because of its unique warning capability, the NOAA Weather Radio system was designated in January 1975 by the White House Office of Telecommunications Policy as the sole Federally operated radio system to provide warnings directly into people's homes—not only for natural disasters, but also in the event of nuclear attack.

What kind of receiver is needed? One that will receive very high frequency FM broadcasts—considerably above commercial FM broadcasts, which end at 108 megahertz. The frequencies used for NOAA Weather Radio, nationwide, are, 162.40, 162.475, or 162.55 megahertz. Most radio-specialty shops and many other retail outlets have such "high band" receivers, some for as little as $10 or $15—if you don't care to have the automatic storm-warning feature.

Effective range of the broadcasts is about 40 miles, depending upon the terrain and the quality of the receiver. Because of the high frequency, transmission is by line of sight, like television, and may be blocked or interfered with by hills, nearby buildings, or commercial radio transmitters. Such problems may sometimes be overcome, or listening range extended, by use of high-quality receivers and high, outside antennas.

Because of these uncertainties, the Weather Service advises people to make final acceptance of a receiver conditional upon a test in the setting in which it is to be used. It urges institutional buyers to select a high-quality receiver with great sensitivity and selectivity.

It's also worth noting that you can purchase receivers that will pick up NOAA Weather Radio broadcasts when you're traveling, as you move from the range of one station to another, so that you will have a continuous source of local weather reports. As the system grows, you will seldom be out of range of a local NOAA Weather Radio broadcast for very long when traveling on interstate highways.

Another boost to NOAA Weather Radio —especially in areas where tornadoes, flash floods and hurricanes are a chronic threat— has been extension of the broadcasts by retransmission over cable television. There are now hundreds of cable-TV companies, serving one out of every eight homes. Many are relaying NOAA Weather Radio broadcasts over designated but otherwise unused channels. Support to NOAA Weather Radio by the broadcast industry doesn't stop with cable-TV. An increasing number of radio stations are taping NOAA Weather Radio as a convenient means of staying up on weather conditions. Some of them are using the recordings as an information source for rebroadcast by their own announcers. Others are retransmitting the broadcasts directly. Many stations have bought warning-alarm receivers to be sure of getting severe weather watches and warnings for immediate relay to their listeners. Still other radio stations are tapping into broadcast consoles at Weather Service offices directly by means of land lines, rather than receiving the messages over the airwaves. This assures them of the highest quality signal, and, perhaps more importantly, provides NOAA with an alternate transmitting source in weather emergencies where the NOAA transmitter has been rendered inoperative for any reason.

In Earl Estelle's words: "We are delighted by the various ways the electronic media are cooperating in this program. They are undoubtedly helping us to do a more

effective job, especially in storm-warning situations. While we are sure the number of NOAA Weather Radio receivers in the hands of the public will continue to grow, we also know that commercial radio and television will continue to be the primary means by which most people get their weather information." Of continuing interest to Weather Service officials is the variety of ways NOAA Weather Radio is being put to use by the public, and the enthusiasm with which it is received.

Examples:

A spokesman for a Methodist church group in Indiana reported: "We listen at least twice a day. Persons travel to and from our church camps from a radius of 150 miles almost every day of the year. We use it as a check for scheduling plane rides two to four days in advance. Keep up the good work."

The general manager of an electric cooperative in Carrolton, Ohio, commented: "We try, during the winter and summer storm seasons to listen to our Weather Radio at least once each hour, right after the update, to see what is developing. When it appears we are due for snow, wind or other weather extremes that could create power outages, we alert additional standby personnel before they go home for the day. This has been convenient for them and insures us of the personnel we will need. During last January's blizzard, we assumed at first the storm was over the first day when the winds began to subside. We were going to work our men straight through the day until the lines were back up. However I checked the Weather Radio and found that lots more stormy weather was on the way. So our plan changed dramatically. We sent some men home for rest breaks so we would have fresh personnel for the night hours. Without this information we would have been in much worse shape on the days that followed."

A school superintendent in Massillon, Ohio, said: "With the radio broadcast and the instant storm warnings, we are able to make better, faster decisions about closing school early, or cancelling school due to weather conditions." He said he found it especially useful during last winter's blizzards.

A radio station in Peoria, Ill., editorialized: "For those of you who may have missed or overlooked it in the news . . . the National Weather Service in Peoria is now on the air with 24-hour weather news. You can now have instant weather at your fingertips in your home. . . . Needless to say this service is a must during tornado season in our area. . . . In central Illinois this receiver is not a luxury; it's a necessity. You should think seriously about getting one for your home or office."

A businessman in Shawneetown, Ill., wrote: "I listen to your broadcast every day and I thank you for your instant weather and river reports. I have a fish market and have been in business for about 33 years. (The Weather Radio) is the finest thing that could have happened to my business. All the farmers depend on my giving the river report when we have a quick rise. Keep up your good work."

A nursery operator in Huntingburg, Ind., wrote: "Just a note to tell you how much we need and appreciate your Weather Radio broadcasts. We must harvest plants throughout the winter and use your broadcasts every morning. We especially appreciate the long-range forecasts, as we can do some planning of work and labor needs."

A Nebraska newspaper, commenting on a tornado episode, editorialized: "Tuesday morning those with Weather Alert radios heard their first alert signal almost an hour before the storm hit."

Bill McKee, Executive Officer for the Weather Service's Eastern Region, reported that during the Tall Ships parade in New York Harbor honoring the Nation's Bicentennial, there was so much random communication on Coast Guard channel 16 by recreational boaters and other vessels that the Coast Guard found it difficult to get through with urgent communications. So a message was broadcast over the NOAA Weather Radio Station in New York City to leave channel 16 free for vital messages. So effective was this request that the Commander of the Third Coast Guard District later wrote Eastern Region Weather Service headquarters thanking them for this assistance. He said Channel 16 was cleared within a half hour after the Weather Radio broadcast—a welcome testimonial to the size and responsiveness of the NOAA Weather Radio listening audience afloat.

Robert K. Goodwin of Des Moines, Iowa, wrote: "Thank you for the wonderful service—continuous weather information—that you provide over KEC-75 from our airport. I am no longer very active in business, but I do find it most valuable in keeping me off the roads during bad weather . . . I am sure that it is of great value to those who are active, especially our farmers. You dispense the weather information in a direct, succinct manner that is right to the point. I hope that it will continue and be expanded so that others may benefit."

Clyde W. Crawford of Birmingham, Ala., wrote: "I think these broadcasts are the greatest thing to come to Birmingham in this century. Your broadcasts are the first thing I listen to before I get up and the last thing I listen to before I go to sleep."

Louis C. Scharfenstein of Jefferson, La., writing to Secretary of Commerce Juanita Kreps, said: "Please accept my thanks for the outstanding job of the National Weather Service in reporting the weather conditions in the Gulf Coast area and especially New Orleans. I am grateful for the immediate availability of a complete weather forecast at the touch of a fingertip on my Weather Radio."

The administrator of South Highlands Hospital in Birmingham, Ala., called NOAA Weather Radio "an excellent community service," adding: "We have purchased a Weather Radio which keeps our maintenance department up to date on anticipated severe weather that could or could not create heating and mechanical problems for us. The guesswork is taken out of weather problems that might make it more difficult for us to operate the hospital."

The president of Coosa Cable Company in Pell City, Ala., wrote: "I must tell you how much I like NOAA Weather Radio station KIH-54. I am carrying this on channel 12 as the sound portion, and of course the weather wire with character generator for the video printout. These two in combination are providing 875 customers with the best weather information they can get, and they really like it."

A representative of American Roofing and Heating, Inc., in Lansing, Kans., commented that the Weather Service broadcasts provide information "that helps us greatly in our roofing operations and all outside work."

One of the more exhaustive surveys of listener reactions was made by the Columbia, S.C., Weather Service Forecast Office, under the direction of Meteorologist in Charge John C. Purvis.

His official controls station WXJ-20 at Columbia and WXJ-22 at Florence, S.C. Last spring, a message soliciting listeners to comment by mail was broadcast over the air. The result was about 100 replies, almost all highly favorable.

The range of occupational and recreational uses was particularly impressive, along with the responses from people who simply wanted to know what the weather would be so they could plan what to wear, how to dress the children for school, whether to hang clothes out to dry, whether to plan a shopping trip, or stay home and read a good book.

The spectrum ranged from the obvious, such as farmers, commercial fishermen, aviators, outdoor construction workers, school and hospital administrators, and outdoor recreationists, to the manager of an FM station at Columbia Bible College who repeated the information over the air, a realtor planning his work schedule, a representative of a textile supply company, a furniture company owner, the manager of a hardwood sawmill scheduling work for loggers, truck drivers, mill and yard supervisors, the manager of a trailer park planning the best time to put in grass seed, the owner of a TV store who kept the Weather Radio on constantly as an attraction for customers, conservation workers, an outdoor worker in a railroad yard, the plant engineer of Columbia College, and the owner of a retail store catering to bass fisherman.

Many of the writers were especially grateful for the timely and informative warnings of thunderstorms and tornadoes. Letters from two women summed up the sentiment neatly. Mrs. Chanie Beard of West Columbia wrote: "You have come to be a dependable necessity and we thank you." Mrs. Harry Ivey of the same locality said: "Just keep up this most helpful service! I would hate to do without it." □

NOAA Weather Radio Transmitters In Operation As Of October 1, 1978

The number following each city identifies the radio frequency on which the station transmits. They are:

(1) 162.550 MHZ
(2) 162.400 MHZ
(3) 162.475 MHZ

Alabama
Anniston ..... (3)
Birmingham ..... (1)
Dozier ..... (1)
Florence ..... (3)
Huntsville ..... (2)
Louisville ..... (3)
Mobile ..... (1)
Montgomery ..... (2)
Tuscaloosa ..... (2)

Alaska
Anchorage ..... (1)
Cordova ..... (1)
Fairbanks ..... (1)
Homer ..... (2)
Juneau ..... (1)
Ketchikan ..... (1)
Kodiak ..... (1)
Nome ..... (1)
Seward ..... (1)
Sitka ..... (1)
Valdez ..... (1)
Wrangell ..... (2)
Yakutat ..... (1)

Arizona
Phoenix ..... (1)

Arkansas
Fayetteville ..... (3)
Fort Smith ..... (2)
Gurdon ..... (3)
Jonesboro ..... (1)
Little Rock ..... (1)
Star City ..... (2)
Texarkana ..... (1)

California
Coachella ..... (2)
Crescent City, Calif. Brookings, Oreg. (1)
Eureka ..... (2)
Fresno ..... (2)
Los Angeles ..... (1)
Monterey ..... (2)
Point Arena ..... (2)
Sacramento ..... (2)
San Diego ..... (2)
San Francisco ..... (1)
San Luis Obispo ..... (1)
Santa Barbara ..... (2)

Colorado
Denver ..... (1)

Connecticut
Hartford ..... (3)
Meriden ..... (2)
New London ..... (1)

Delaware
Lewes ..... (1)

District Of Columbia
Washington, D.C. ..... (1)

Florida
Fort Myers ..... (3)
Daytona Beach ..... (2)
Gainesville ..... (3)
Jacksonville ..... (1)
Key West ..... (2)
Melbourne ..... (1)
Miami ..... (1)
Orlando ..... (3)
Panama City ..... (1)
Pensacola ..... (2)
Tallahassee ..... (2)
Tampa ..... (1)
West Palm Beach ..... (2)

Georgia
Atlanta ..... (1)
Augusta ..... (1)
Chatsworth ..... (2)
Columbus ..... (2)
Pelham ..... (1)
Savannah ..... (2)

Hawaii
Hilo ..... (1)
Honolulu ..... (1)
Kokee ..... (2)
Mt. Haleakala ..... (2)

Illinois
Chicago ..... (1)
Moline ..... (1)
Peoria ..... (3)
Rockford ..... (3)
Springfield ..... (2)

Indiana
Evansville ..... (1)
Fort Wayne ..... (1)
Indianapolis ..... (1)
Lafayette ..... (3)
South Bend ..... (2)

Iowa
Des Moines ..... (1)

Kansas
Colby ..... (3)
Concordia ..... (1)
Dodge City ..... (3)
Ellsworth ..... (2)
Topeka ..... (3)
Wichita ..... (1)

Kentucky
Ashland ..... (1)
Bowling Green ..... (2)
Covington ..... (1)
Hazard ..... (3)
Lexington ..... (2)
Louisville ..... (3)
Mayfield ..... (3)
Somerset ..... (1)

Louisiana
Baton Rouge ..... (2)
Lake Charles ..... (2)
Morgan City ..... (3)
New Orleans ..... (1)
Monroe ..... (1)
Shreveport ..... (2)

Maine
Ellsworth ..... (2)
Portland ..... (1)

Maryland
Baltimore ..... (2)
Salisbury ..... (2)

Massachusetts
Boston ..... (2)
Hyannis ..... (1)

Michigan
Alpena ..... (1)
Detroit ..... (1)
Flint ..... (2)
Grand Rapids ..... (1)
Marquette ..... (1)
Sault Ste. Marie ..... (1)
Traverse City ..... (2)

Minnesota
Duluth ..... (1)
Int'l. Falls ..... (1)
Mankato ..... (2)
Minneapolis ..... (1)
Rochester ..... (3)
Thief River Falls ..... (1)
Willmar ..... (2)

Mississippi
Ackerman ..... (3)
Booneville ..... (1)
Bude ..... (1)
Gulfport ..... (2)
Inverness ..... (1)
Jackson ..... (2)
McHenry ..... (3)
Meridian ..... (1)
Oxford ..... (2)

Missouri
Camdenton ..... (1)
Hannibal ..... (3)
Kansas City ..... (1)
St. Joseph ..... (2)
St. Louis ..... (1)
Springfield ..... (2)

Montana
Great Falls ..... (1)
Helena ..... (2)

Nebraska
Omaha ..... (2)

Nevada
Reno ..... (1)

New Hampshire
Concord ..... (3)

New Jersey
Atlantic City ..... (2)

New Mexico
Albuquerque ..... (2)
Clovis ..... (3)
Farmington ..... (3)
Hobbs ..... (2)
Ruidoso ..... (1)
Santa Fe ..... (1)

New York
Buffalo ..... (1)
New York City ..... (1)
Rochester ..... (2)

North Carolina
Cape Hatteras ..... (1)
New Bern ..... (2)
Wilmington ..... (1)

North Dakota
Fargo ..... (3)

Ohio
Akron ..... (2)
Caldwell ..... (3)
Cleveland ..... (1)
Columbus ..... (1)
Dayton ..... (3)
Lima ..... (2)
Sandusky ..... (2)

Oklahoma
Lawton ..... (1)
Oklahoma City ..... (2)
Tulsa ..... (1)

Oregon
Astoria ..... (2)
Coos Bay ..... (2)
Eugene ..... (2)
Newport ..... (1)
Portland ..... (1)

Pennsylvania
Erie ..... (2)
Philadelphia ..... (3)
Pittsburgh ..... (1)

Puerto Rico
San Juan ..... (2)

Rhode Island
Providence ..... (2)

South Carolina
Beaufort ..... (3)
Charleston ..... (1)
Columbia ..... (2)
Florence ..... (1)
Greenville ..... (1)
Myrtle Beach ..... (2)

Tennessee
Bristol ..... (1)
Chattanooga ..... (1)
Knoxville ..... (3)
Memphis ..... (3)
Nashville ..... (1)

Texas
Abilene ..... (2)
Amarillo ..... (1)
Austin ..... (2)
Big Spring ..... (3)
Brownsville ..... (1)
Bryan ..... (1)
Corpus Christi ..... (1)
Dallas ..... (2)
Del Rio ..... (2)
Fort Worth ..... (1)
Galveston ..... (1)
Houston ..... (2)
Laredo ..... (3)
Lubbock ..... (2)
Lufkin ..... (1)
Midland ..... (2)
Paris ..... (1)
Pharr ..... (2)
San Antonio ..... (1)
Victoria ..... (2)
Wichita Falls ..... (3)
San Angelo ..... (1)
Sherman ..... (3)
Tyler ..... (3)
Waco ..... (3)

Utah
Salt Lake City ..... (1)

Vermont
Burlington ..... (2)

Virginia
Norfolk ..... (1)
Richmond ..... (3)

Washington
Neah Bay ..... (1)
Seattle ..... (1)
Yakima ..... (1)

West Virginia
Charleston ..... (2)
Clarksburg ..... (1)

Wisconsin
Green Bay ..... (1)
LaCrosse ..... (1)
Madison ..... (1)
Menomonie ..... (2)
Milwaukee ..... (2)
Wausau ..... (3)

NOAA Profile

Saving The

Ingenuity Made Him A

Richard McNeely assists tuna fishermen to install the new "super apron" in the tuna seine.

IN 1971, more than 312,000 porpoise were killed incidental to U.S. yellowfin tuna fishing in the eastern tropical Pacific. In 1977, approximately 25,000 were killed.

There are many reasons for this dramatic reduction. The fishing skippers themselves have developed new techniques, and the National Marine Fisheries Service has instituted regulations that have done much to aid the reduction.

The single most important element, however, is the improved gear that is now used. And critical to these improvements have been the ingenuity, diligence and patience of Richard McNeely of the Northwest and Alaska Fisheries Center in Seattle.

McNeely, who has been involved with development of fishing gear for 23 years, was aware of the problem of porpoise deaths in tuna nets long before it became a national issue. In fact, he was at sea on a tuna seiner investigating causes of porpoise mortality when word came over the radio in 1972 that the Marine Mammal Protection Act had become law.

The problem that confronted the tuna industry in the early 1970's was severe indeed.

For reasons still unknown to science, yellowfin tuna swim beneath schools of porpoise. Using the porpoise to locate the tuna, the tuna seiners herd them in a group with speedboats, and then place their nets around porpoise and tuna alike. As the net is drawn in, some of the poropise may be caught beneath the surface in the net. Because they are airbreathing mammals, they drown.

Although U.S. tuna boats have been catching tuna for almost 50 years, the problem witht the porpoise did not arise until the later 1950's and early 1960's. Prior to the 50's, tuna were caught with the use of fishing poles rather than nets. The men would stand along the side of the boats, cast bait into the water, and—when the fish began a feeding frenzy—would pull them into the boat with barbless hooks. This was a backbreaking job, and it became increasingly difficult for skippers to find crews willing to spend long days at sea performing such an arduous task. To add to the problem, the bait then used became more difficult to obtain.

Conversion of live bait clippers to seiners began in the late 50's, and by the early 60's, almost all tuna boats were using purse seine nets. Because the nets were so large, two developments were required—fabrication with nylon to give them the necessary strength without the great weight of cotton, and the invention of the Puretic powerblock. The powerblock is a hydraulically powered, large rubber roller on the end of a boom which replaces manpower in dragging the huge nets back on board.

The Marine Mammal Protection Act of 1972 made it unlawful to catch, harass, or kill marine mammals. It did provide for taking of marine mammals incidental to tuna fishing for yellowfin tuna subject to certain conditions. The tuna industry was given two years to develop techniques and gear which would reduce the number of porpoise that were killed in the fishery.

In the fall of 1974, the National Marine Fisheries Service published detailed regulations to meet the objectives of the Act by reducing the number of porpoise killed in the fishery.

As in almost all new undertakings, there were periods of trial and error in the formation of the regulations and in the development of the fishing techniques.

One of the earliest techniques was a process developed by Captain Ernest Medina, one of the leading tuna skippers. This process or maneuver of "backdown" is performed after the net has been closed around the schools of porpoise and tuna and the net is being pulled abroad through the powerblock. As the area of the net becomes smaller, the skipper backs the ship down, causing the far end of the net to dip under the water. When the net is in this position, the porpoise normally congregate at the far end of the net and the tuna tend to school between the porpoise and the ship. When the end of the net drops below the water, the porpoise can swim over the net to freedom.

This was only a beginning in the search for a solution to a problem that threatened the existence of one of the major fishing industries in the United States.

Captain Harold Medina later tried smaller mesh netting in the backdown area where the porpoise were most likely to become entangled. With the use of small (2") mesh, the porpoise were more likely to bounce off the net and come to the surface rather than becoming entrapped in the net. The use of the smaller mesh net around the top of the net to depths of approximately 30 feet became known as the Medina panel and was required in the early tuna/porpoise fishing regulations.

Although most of the porpoise managed to escape the net during backdown, many

Porpoise

Gold Medal Winner

By GERALD D. HILL, JR.

were still being trapped in the nets by catching their flippers and snouts in the webbing. Not only that; many skippers were wary of the backdown procedure because of an occasional loss of tuna over the submerged corks. Many times, when the skipper stopped backing down to allow the corkline to come to the surface to prevent loss of tuna, the net would collapse on the porpoise, hopelessly entangling them.

"I know of this fear of loss of tuna that the skippers had during backdown and began to study ways that would keep the tuna in the nets and allow the porpoise to get out," says McNeely.

McNeely observed that significant numbers of porpoise were still being caught in the 2″ mesh of the shallow Medina panel and others were caught in the larger 4¼″ mesh beneath it. He then began experimentation with much smaller (1¼″) netting, installed to a much greater depth (60′) and length (1,000′), around the perimeter of the backdown channel.

The tuna seiner *Bold Contender* was leased late in 1975 to the National Marine Fisheries Service and used by Dick McNeely to test the new fishing gear under normal fishing conditions at sea.

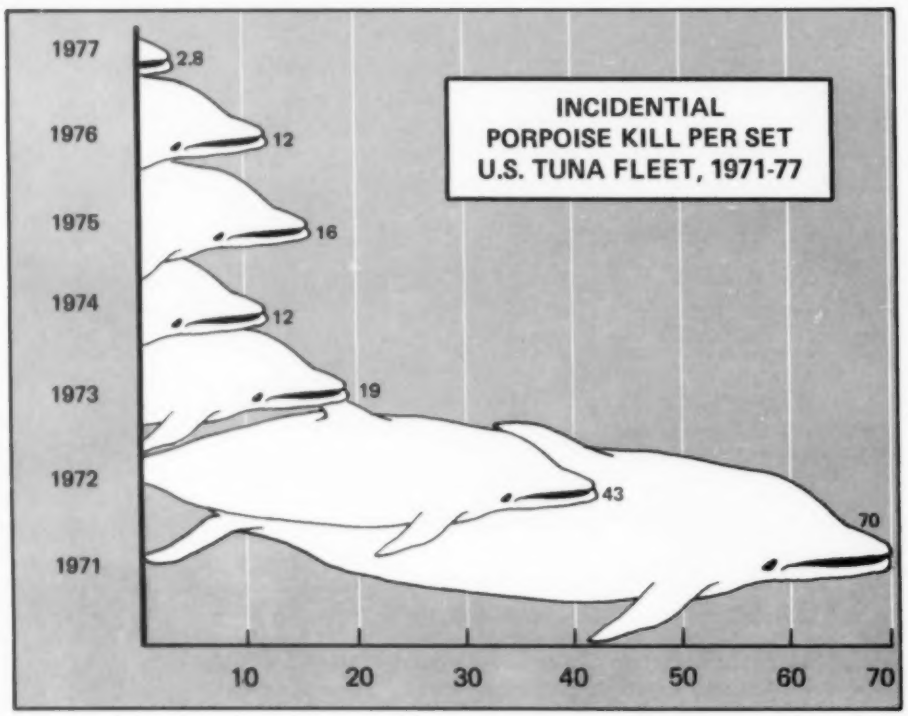
As a result of experiments at sea, one of the most important innovations was the idea of a "porpoise apron" of small mesh netting around the top of a standard purse seine, which formed a protective shallow ledge at the back of the net and made it easier for the porpoise to escape, but more difficult for the fish to escape.

"In addition, a small rubber boat was used at the back of the net to assist the porpoise over the net. I think this had a psychological impact on the skippers since they knew they had a man at the back of the net who could signal them when there was no tuna in the area in danger of escaping from the net. Moreover, the man in the raft could help the porpoise over the net," said McNeely.

"Much credit must go to the skippers of the vessels," says McNeely. "Although most of the changes in the design of the equipment are evolutions from previous gear and not radical new design, each change in the nets makes it perform differently, and the skippers must become accustomed to the changes in the behavior of the nets," says McNeely.

Even so, on the first try with the *Bold*

A tuna boat in the final stages of backdown, with porpoises escaping over the end of the net at lower left.



Top photo shows fishermen helping porpoises escape from the net during backdown.

The chart above shows the trend of porpoise mortality in U.S. tuna purse-seine fishery.

Contender system, Captain John Golsalves set a new low in the number of porpoise killed in the net. During 31 sets made with the new system, it was estimated that more than 21,000 porpoise were encircled in the net. Of this number, only 121 porpoise were killed, an average of 0.56 percent killed of those netted. During the sets, 545 tons of yellowfin tuna were caught resulting in 3.9 kills per set and 0.22 porpoise killed per ton of tuna. The fleet average in 1975 was 0.9 porpoise killed per ton of tuna caught.

The kills would have been even lower if it had not been for a high risk experimental set made at the request of the chief scientist on board. Because of the sea conditions, the set ended in disaster when the net collapsed on the porpoise and nearly one half of all the porpoise killed in the entire 31-set test occurred in this one set. On the plus side, no porpoise were killed in 15 of 25 consecutive sets, and seven of the 15 zero kills were consecutive.

"To say we were delighted and encouraged by the test of the *Bold Contender* system would be the understatement of the year," says McNeely. "We decided to test the system in the fleet and equipped 10 vessels with the system. Ten other vessels were equipped with fine-mesh systems only. Each of the vessels had government observers on board to record the results. Cost of the tests were shared by government and the tuna industry. The first results obtained from the use of the *Bold Contender* system were amazing—there was no statistically significant difference in the kill of the ships using the total system from those using the small mesh only. This was very discouraging. Then it dawned on me that the skippers were in a learning process. We threw out these first reports and chalked them up to learning about new gear. From then on, we struck pay dirt. After they learned to use the new gear, we found that it was three times more effective than any that had ever been used before."

The *Bold Contender* system, although successful, was subject to excessive sinking. McNeely then came up with another modification—the top of the trapezoid portion of the net, which had a radical change of taper causing it to sink was eliminated, and the "super apron" installed.

During late 1976, the *Bold Contender*/ super apron net was tested on another charter vessel, the *Elizabeth C.J.* These tests were even more successful than those of the *Bold Contender*. Only 11 porpoise were killed from an estimated 15,000 encircled in the net. Scientific personnel on board tell us that of the 11 kills only one of them resulted from the use of the gear. The other 10 were killed as scientific personnel attempted to attach radio locator transmitters to the porpoise.

What are the results of the years of testing and modifying the gear and fishing techniques of the tuna fishers? In 1972, over 304,000 porpoise were killed in the tuna nets. During the years that followed, the kills were 1973—175,000; 1974—97,000; 1975—134,000; 1976—103,000.

Photo: Bill High

In late 1976, the entire U.S. tuna seine fleet began changing to the new gear systems, and in 1977 most of the vessels were using them.

"The switch to the new system and the dedication of the skippers in making the system work and their desire to reduce the number of kills have brought us a drastic reduction in the porpoise kills in the yellowfin tuna purse seine fishery," says McNeely. "Federal regulations require that the kill be reduced to 62,429 in 1977; 51,945 in 1978; 41,610 in 1979; and 31,150 in 1980. The 1980 goal has already been surpassed. In 1977, the kill was about 25,000 and as of the middle of June this year, the kill was approximately 4,000 animals," said McNeely.

McNeely has been instrumental in other activities to reduce the porpoise kills. He began to study the causes of "disaster" sets and noted that most were caused by collapsed net prior to backdown and improper backdown procedures which permitted the nets to fold over and suffocate the porpoise. He then wrote a widely circulated handbook on how to avoid these sets.

McNeely and the fishers also have been assisted by the porpoise themselves. Michael Orbach, in his excellent book—*Hunters, Seamen and Entrepreneurs*—tells us: "When seining was first introduced into the tuna fleet, it was possible to round up a school of porpoise easily with the seiner and one or two speedboats. As the porpoise came into contact with more and more seiners, however, they became harder and harder to work. Now it takes five speedboats to work most schools, and even then it is impossible to get many of them to bunch together, much less to stop and mill around in one spot. Instead they wander off in small groups seemingly impervious to the antics of the speedboats, often even playing under the speedboat much the same as they do under the bows of larger ships. The whole school may shift direction rather than allowing itself to be "pushed" together. Often they will dive and remain submerged for long period of time to avoid the nuisance of the speedboats. Even more frustrating, different species of porpoise and porpoise in different areas of the Pacific seem to have consistent strategies for dealing with the seiners."

McNeely's efforts have been recognized by those outside the industry. In 1977, Richard McNeely received the highest award bestowed by the Department of Commerce—the Gold Medal—and this year he was named Man of the Year by the American Cetacean Society.

Is McNeely resting on his laurels? Hardly. He is still working at the National Marine Fisheries Service's Northwest and Alaska Fisheries Center in Seattle, Washington, on further improvements to commercial fishing gear and scientific sampling systems needed for effective management, observation, and wise use of our living marine resources. He occasionally provides advice and counsel to scientists at the Southwest Fisheries Center on our continuing research aimed at further reduction in porpoise mortality rates, and, he hopes, new fishing systems not involving capture of porpoise. □

NWS Emergency Broadcast System

Lengthening The Lifeline

By NANCY PRIDGEON

On a summer's night in North Dakota, at about a quarter after ten, a flash flood warning is called by the National Weather Service for Bismarck and the surrounding counties. Minutes later, area residents hear the message and begin to prepare for the worst.

In Paragould, Ark., employees of radio station KRDS open the back door as they are leaving for home and find a tornado staring them in the face. Seconds later, the station broadcasts the word about the emergency, and the town's disaster preparedness plan goes into action.

In Laconia, N.H., a tanker filled with 9,000 gallons of liquid propane overturns in a populated area. Local radio station WEMJ remains on the air throughout the night with evacuation notices and half-hourly live reports from the scene.

In Charleston, W. Va., Governor John D. Rockefeller IV takes to the airwaves to broadcast a message far and wide that a crippling blizzard is on the way. His warning is heeded by citizens prepared to do battle with the icy monster.

These are stories of people in the vicinity of a hazard who got the message in time to react effectively. Getting the message was as easy as listening to the radio or watching TV; it wasn't even necessary to change channels. The incidents, and many more like them, are the fulfillment of everything Joe Conte, NWS Emergency Boardcast System Program Manager, has tried for the past two years to achieve for his program—to forge another link in Weather Service's watch-warning-preparedness chain.

"The two-year program," Conte said, "was designed to revitalize and prominently place the Emergency Boardcast System on the Nation's most-wanted list."

Severe weather and other emergencies demand quick action on many fronts so that every person who may be in danger may be warned in time. Already in operation by the Weather Service are such technical achievements as the NOAA Weather Radio (which requires a special receiver) and the NOAA Weather Wire (available by subscription). To make the chain stronger, a way was needed to send the warning directly into the greatest number of private homes that possibly could be reached.

The Emergency Broadcast System offered one solution, but before it could be considered an effective tool, new ways had to be sought to bring the system up to date, to enlist the aid of community disaster preparedness agencies, and to motivate each community's broadcast media to put themselves into the picture as an important voluntary link.

FCC Commissioner Margita E. White participated in the activation ceremonies for Georgia's Emergency Broadcast System in November 1977. To her right are Georgia Governor George Busbee (with glasses) and the Defence Civil Preparedness Agency's Frank Vogel.

To do all this, Conte, Federal Communications Commission staffer Ray Seddon, and Bill Beatty of the Defense Civil Preparedness Agency traveled more than 100,000 air miles, journeying to all 50 States, Puerto Rico and the Virgin Islands, Gaum and the U.S. Trust Territories. All along the way, they were given a hand by Federal Communications Commission, Defense Civil Preparedness Agency, and National Weather Service employees in the field.

The Emergency Broadcast System first came to life in 1964 to give the President of the United States a way to get in touch surely and quickly with the American people in the event of war, threat of war, or grave national emergency. It replaced the World War II-generated CONELRAD (Control of Electromagnetic Radiation) system, where a single, continuous tone alerted the listener to tune to the 640 or 1240 band on AM radios to hear what danger was imminent.

The CONELRAD system worked by putting into action a network of broadcasters—radio station personnel—previously configured and trained, to get word to the people and activate civil defense and Red Cross plans to instruct people what to do or where to go. CONELRAD was intended to hold the country together and unify responses to military threats.

The new Emergency Broadcast System works the same way, with two important differences. CONELRAD preempted two radio bands and all other stations went off the air, but EBS uses all radio stations, all TV stations, all available broadcast frequencies. CONELRAD was activated only from the top, from the highest office in the land, but EBS also can be activated by State or local public officials, civil defense officials, or the National Weather Service. This means that in addition to the broad sweep of a national alert, EBS can be fine-tuned to pinpoint an exact area of danger, a locale, even a single street.

Participating in the system today to give the national alerts are the Aerospace Defense Command (ADCOM) and the Federal Preparedness Agency (FPA). On the local level are State emergency communications committees, local operational area emergency communications committees, State associations of broadcasters. On the national level are the National Association of Broadcasters and the National Industry Advisory Committee. The Federal civilian agencies participating are the Federal Communications Commission (FCC), Defense Civil Preparedness Agency (DCPA, formerly the Office of Civil Defense), and NOAA's National Weather Service, that have taken the lead in working to make the system a success.

The plan of action for the three Federal lead agencies began with a purpose, a schedule, and a timetable.

The purpose was to persuade State and local broadcast stations to develop written plans for reacting to sudden emergency situations, whatever their nature, and to help

Bill Beattie, DCPA, Washington, Ray Seddon, FCC, Joe Conte, NOAA

State and local community preperedness committees to develop written plans for community response. To do this, it often was necessary to overcome the apathy and the preception of broadcasters that the existing State and local Emergency Broadcast Systems were fragmented and uncoordinated.

The schedule called for seminars and workshops to be held in each State, arranged by each State's emergency communications committee and co-chaired with a State or local representative of its office of emergency services or disaster preparedness. And meeting with the group of broadcasters, local civil defense officials, and local law enforcement agents were the three Federal agency representatives.

"We'd fly in, pick up the local MIC (NWS Meteorologist-in-Charge), and go to the meeting," said Conte. "And we'd get to the meeting any way we could. Sometimes we went by car; sometimes by plane—sometimes a private plane was furnished by interested parties. We did six cities in Texas in two weeks that way."

About 150 people would show up for the preliminary meeting. The meeting would be held in a hotel, an available hall, or wherever space could be found.

"I know what a political caucus is like," Conte said. "In those meetings, we got together to smooth out the infighting and the little hassles, and to iron out the wrinkles."

During the seminar that followed, Conte presented the Weather Service side, the how and why of forecast and warning. Then the communities were asked for input on what they would need—help in writing a community plan was always given by DCPA in a workshop.

If the seminar were going well, the group was asked to pick a common station to act much as the pool stations act during important political broadcasts—that is, one station would agree to act as the focal point, to collect and to broadcast emergency information simultaneously over all stations in a community.

In past emergency situations, most radio and television stations functioned admirably as individual stations, getting important life-saving information to the public as quickly as it could be gathered by the station's staff. In the Emergency Broadcast System, all radio and TV stations have access to all information and also provide important feedback to the common carrier.

The results can only be in the public's best interest: simultaneous broadcast of warnings and preparedness information by all the stations in the community; authentication of emergency instructions; and interconnection of all types of communications systems—police and fire radio, amateur radio and citizens band radio—into a coordinated system.

To help each community prepare for a potential disaster, DCPA urges that written procedures be tested and rehearsed well in advance so that officials, broadcasters, and the public are familiar with the emergency plan and will know just what to do when time is short.

Should an emergency occur, there are many ways available—radio, telephone, Associated Press and United Press International wire service, the NOAA Weather Wire teletype, the NOAA Weather Radio—to activate EBS, to get the message to the EBS "Common Program Control Station." This key station is the one that will push the button. So the public will get the word, no matter what station may be turned in at the time.

At the beginning of the project, it seemed a monumental task. Conte wrote articles for broadcasters' in-house magazines. He helped write the EBS national plan and construct the national agreements. He set up the visitation schedule and coordinated the action.

"It was a low budget project," he said, "around $100,000 total cost."

The cost was borne by all three agencies. Conte wrote the script; the publications, presentation slides, and artwork were done by DCPA. When the scheduling was ready, the timetable came into focus. The project was slated to run from October 1976 to October 1978.

All was not rosy out on the road. While many communities entered enthusiastically into the system, some resisted the idea. During a seminar that took place in the State of Washington, for example, one topic was the danger of radioactive emissions from a nuclear plant close by. One member of the press attending the meeting objected that there was no problem, and the meeting ended with no decision made. But three days after the team departed there was a local radioactive explosion. The community lost no time in putting a plan into effect for the next emergency.

While it would not be true to say that the EBS team scheduled its seminars to mesh with weather emergencies, if an emergency were expected, its proximity was usually put to good use.

At the Little Rock, Ark., seminar, there was a tornado warning in effect during the meeting; the tornado hit Fort Smith just as the seminar wound up. During the meeting, the attendees were kept posted by the MIC, who was tied in to the forecast office and used the stage microphone to give the latest word to the assembly.

In California, a tropical storm came up the coast while the EBS team was in the area, so the meetings held at San Francisco and Fresno got "blow-by-blow" accounts.

"It did a lot to sell the program," Conte said. "It helped to have something tangible so we could say, 'You, as a broadcaster, are responsible to the people'."

Georgia was one of the first States to activate the Emergency Broadcast System State-wide. The Georgia plan consists of 11 EBS areas. Eleven radio stations act as primary entry points for emergency messages so that the system blankets the State.

In a ceremony held in November 1977, in Atlanta, Georgia's Governor George Busbee presented awards to the persons who brought the system to operational readiness and personally tested the activation with a special test message.

Among those present for the ceremony were Major General Billy M. Jones, Georgia State Director of Civil Defense, local Weather Service personnel, and a host of Washington dignitaries. And members of the EBS team, of course.

The Emergency Broadcast System's biggest advantage, as Conte sees it, is that people do not have to change stations or risk missing a warning that could save their lives. The station they were listening to would bring them the message.

"We're dedicated to getting warning messages in every possible way to all the people possible," Conte said.

Before the program began in 1976, the old EBS was activated fewer than 50 times at the local and State level. According to the FCC, more than 1,000 activations have been put into effect since the beginning of 1977. □

NOAA has key role in international study

Spotlight On The Magnetosphere

By CDR. RICHARD E. NEWELL

Surrounding the atmosphere we breathe is a vast region where charged particles move under the control of the Earth's magnetic field. This outer zone behaves like a solar energy collector—one with a remarkable appetite, but a limited holding capacity. It deals with this dilemma by means of an explosive self-purging mechanism that scientists are just beginning to understand.

The name of this dynamic region is the "magnetosphere," and the global program now underway to investigate it is called the "International Magnetospheric Study" (IMS). NOAA is playing a key role in this 50-nation/50-spacecraft program aimed at bridging the gap between 20 years of exploring near space and a solid understanding of the processes at work there.

The first step along the road leading to the IMS was taken about 400 years ago, when the English physician William Gilbert discovered that the Earth acts like a giant magnet. Much later, in 1722, a famous London clockmaker, George Graham, watched the motion of foot-long compass needles through a microscope to obtain the first evidence that the Earth's magnetic field is quiet on some days, active on others.

Within 20 years, Anders Celsius, Swedish astronomer and inventor of the centigrade thermometer, was sharing in Graham's studies; similarities between their observations at London and Uppsala revealed that there are magnetic "storms" covering a broader area than weather disturbances. Celsius then made the significant discovery that magnetic activity and auroral displays usually occur together, making it clear that these two phenomena must be components of some greater upheaval.

In the 19th century the study went global. Magnetic observations began to spread throughout the world, and many explorers took to the Arctic, bringing back detailed accounts of auroral activity. A young Austrian lieutenant, returning from such an expedition, proposed an international cooperative polar study that became the earliest forerunner of the IMS. This was the International Polar Year of 1882/83, followed 50 years later by a Second IPY. The success of these endeavors led to the International Geophysical Year of 1957/58, an outstanding global enterprise involving 67 nations and embracing all fields of geophysics.

This is when the magnetosphere began to be widely explored firsthand, for the IGY marked the beginning of the space age. Sputnik I and Explorer I went into orbit for science; satellites replaced rockets as the primary high-altitude research probes. It was Explorer I data that led to one of the basic discoveries of the IGY: the doughnut-shaped Van Allen radiation belt of high-energy particles that rings the Earth at the base of the magnetosphere.

In the intervening 20 years, much has been learned about the outer limits of our terrestrial environment. For example, the magnetosphere, so-named early in the space age, is really no sphere at all. It is shaped like a comet, its head centered on the Earth and its flaring open-ended tail extending far past the orbit of the moon. This geometry is the work of the sun and its outflowing "solar wind" of charged particles, or plasma. The high-speed plasma responds to its sudden encounter with the Earth by casting up a giant stationary shock wave. Then it rushes on to compress the sunward side of the geomagnetic field and sweep the night side's outer fringes downwind to form the "magnetotail." Some of this solar wind plasma becomes an important part of the captive population of the magnetosphere, along with charged particles from the Earth's upper atmosphere.

Today's magnetospheric scientist knows what Celsius did not: that the "great upheaval" behind magnetic disturbances is the magnetospheric substorm, the means by which energy packed into the magnetotail by the solar wind explodes earthward. Auroral displays are simply the visible evidence of such explosions. The view from space available to today's investigator reveals that these displays occur along a nearly circular belt, a diffuse night-light called the "auroral oval." It surrounds each magnetic pole but only is seen on the Earth's darkened side. The colorful, dancing auroral arcs and bands are swarms of electrons, beamed from on high during a spectacular convulsion of the magnetosphere.

We now realize that the magnetic storms that Graham and Celsius observed through compass microscopes consist of a rapid succession of intense substorm convulsions, and that the storm effect extends far beyond the distance from London to Uppsala—it spans the globe.

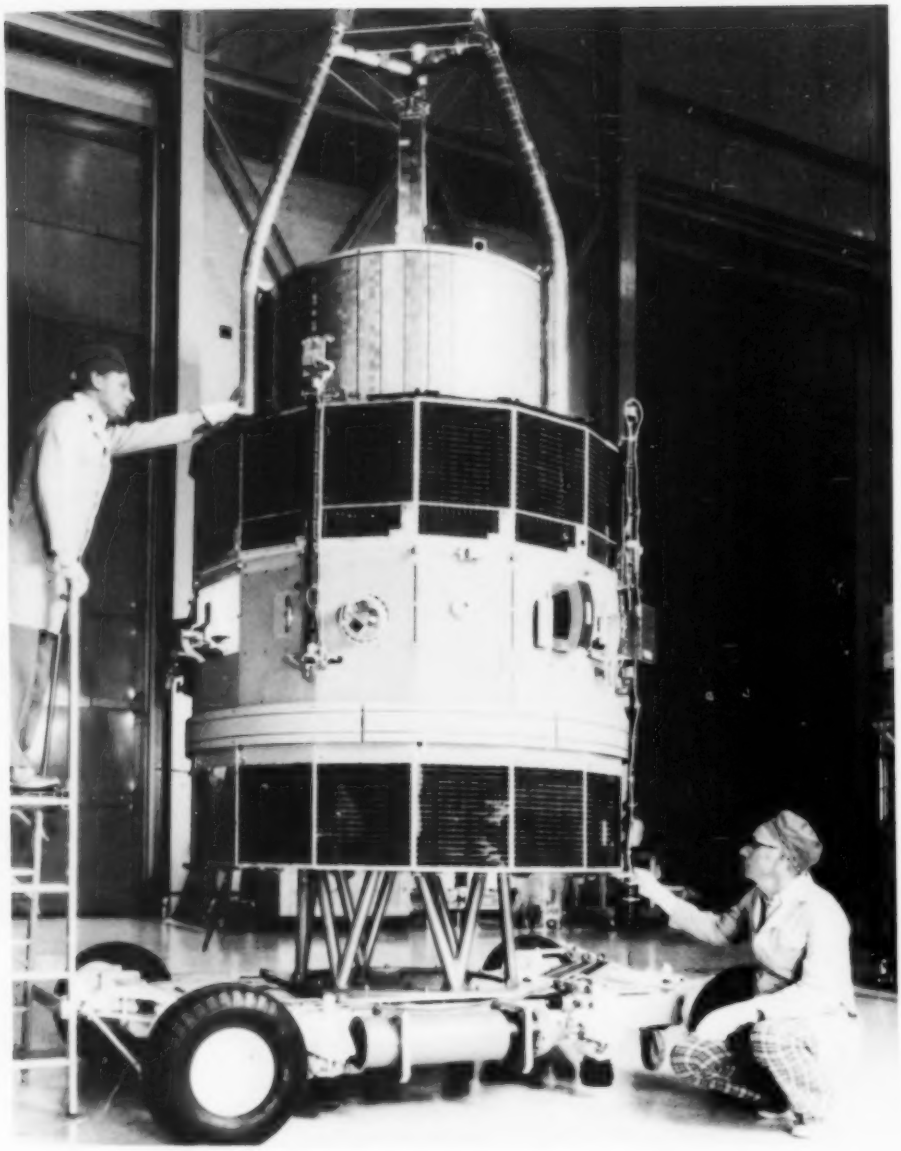
The International Magnetosopheric Study of 1976-79 is the first attempt to probe the magnetosphere as a whole. It is also the first international effort to be built around a set of satellites. These are the European Space Agency's (ESA) GEOS satellites and NASA/ESA's three International Sun-Earth Explorer (ISEE) satellites, two together in Earth orbit and one in a sun-centered orbit that keeps it directly "upwind" of the magnetosphere. IMS-dedicated satellites also have been orbited by the Soviet Union and Japan. All of these, together with other satellites launched during and before the IMS, bring the number of IMS-contributing spacecraft to about 50.

Since satellites can do only so much, the orbital observations are tied in with ground-based, balloon, rocket, and aircraft measurements. They provide observations of time variations at fixed sites, special in-depth probing, and a panoramic view of certain near-space events that complement the direct, on-the-spot satellite observations. They also provide opportunities for all countries, not just the high-technology ones, to make significant IMS contributions.

The IMS welcomes all the help it can get, because its goals are ambitious. The purpose is not just to explore, but to answer specific questions in quantitative terms: How does the solar wind inject energy into the magnetosphere? How does the magnetotail release stored energy to create substorms? How does the magnetosphere couple with the atmosphere and share its upper reaches with the electrically charged particles of the ionosphere?

NOAA's IMS role is based primarily in ERL's Space Environment Laboratory (SEL) and EDIS's National Geophysical and Solar-Terrestrial Data Center (NGSDC). Their IMS effort is data-driven, research-and-service oriented, and international in scope.

A case in point involves the launch of two key IMS satellites just a year ago.



ISEE-1 and -2 were boosted into a common orbit from NASA's Eastern Test Range at Cape Canaveral in a multination bid to probe the magnetosphere in a new way. A ground-controlled propulsion engine aboard ISEE-2 allows precise adjustment of the distance separating the satellites. Knowing this distance and using the satellites' identical instruments, scientists can determine whether a magnetic region's boundary layer is moving, and how fast; this allows them to distinguish between space and time changes when gauging the layer's thickness, an important problem that single-satellite measurements can't cope with.

Among the many data-gathering experiments aboard the satellite pair is one cosponsored by SEL and West Germany's Max Planck Institute to obtain high-resolution measurements of energetic protons and electrons. According to Dr. Donald Williams, SEL Director and principal investigator of the experiment, a key objective is to find out how much particle energy, within the range being measured, is being transferred down current-carrying field lines from the thin magnetosphere into the denser ionosphere. This will help to fill in one small piece of the overall energy-transfer puzzle.

As part of its solar-terrestrial quest, SEL is studying this magnetospheric puzzle from top to bottom. For instance, ISEE data will be used to study the entry of solar wind plasma. Scientists believe that many of the captured solar wind particles come in by way of what are called "polar clefts." These portals to the magnetosphere are two high-latitude, dayside magnetic funnels, one in each hemisphere, that reach all the way down to the ionosphere. They "part" the polar magnetosphere, separating the sunward-arcing geomagnetic field lines from the tailward-streaming ones. Some of the solar plasma that flows down into the clefts comes back up along the field lines bordering the funnel and spreads over the entire inner surface of the magnetopause, the magnetosphere's outer boundary. A part of this boundary-layer plasma then drifts inward and becomes part of the tail.

Data from ISEE satellites also will be applied to the inner magnetosphere, the region of closed field lines forward of the tail. Within this region is a great shortage reservoir called the plasmasphere. SEL's Dr. Lawrence Lyons is an avid student of this inner zone, made of "cold" plasma from the underlying ionosphere and "hot" plasma shot up from the ionosphere and forward from the magnetotail during substorms. This hot component makes up the Van Allen radiation belt. Inside it is the ring current, which encircles the globe during magnetic storms to spread the storm effect worldwide. Dr. Lyons recently coauthored an award-winning paper which dispelled the long-held notion that protons were the main constituents of the ring current. He is now exploring some unexpected variations in the population of the radiation belt, and is anxious to see what the ISEE data may reveal about particle gains and losses there.

Other data sources also are being tapped in pursuit of important IMS goals. Dr. Joseph Barfield specializes in the study of magnetic variations, as measured from both satellites and ground stations. In a sense, his interests bridge the gap between SEL's outer and inner magnetospheric studies. One of his focal points is the substorm, the magnetosphere's quick remedy for excessive energy intake.

"If we learn enough about their magnetic variations," says Dr. Barfield, "we may come to understand these substorms well enough to predict them." A reliable substorm forecast would be a boon for practical operations that geomagnetic disturbances play havoc with: over-the-horizon radar systems, long-distance power and telephone lines, and high-frequency radio communications, as well as communication satellites that use the quiet geomagnetic field to orient themselves in space, and mineral surveyors whose magnetic survey data may not allow them to distinguish between a substorm overhead and a mineral deposit underfoot. Even the substorm investigator in Wallops Island, Virginia, or Fort Churchill, Canada, appreciates advance notice of a big event.

Substorms are produced in the magnetotail, the home of the magnetosphere's second great plasma reservoir. This is the "plasma sheet," a thick layer of particles that divides the magnetotail in half lengthwise. The sheet's back-swept field lines map down to the two auroral ovals; a thin magnetic "neutral sheet," sandwiched inside the plasma sheet, separates the field lines rooted in the Earth's northern oval from those rooted in the southern one.

The plasma sheet is the "storm center" of about six substorms per day, on the average —all the result of the magnetosphere's insatiable appetite for solar energy. Energy intake is particularly active when the solar wind's magnetic field, thrown out from the sun along with its plasma, registers a strong southward component. The details are complex and poorly understood, as are many

things that have to do with substorms; but the prevailing view is that this southward orientation enables the solar wind's magnetic field, imbedded in the solar plasma, to merge with the Earth's field where the two first meet, at the head of the magnetosphere. This gives solar wind energy—both magnetic and plasma—easier access to the polar clefts and magnetotail.

In this merging process, a sunward-arcing geomagnetic field line with a foot in each polar cleft is "rushed" by a southward-pointing interplanetary field line. They meet broadside at the head of the magnetosphere. At the point of contact, the lines seem to break and "change hands" to become a pair of "geospace" field lines—each with a foot in one cleft—that are combed back over the clefts and into opposite sides of the magnetotail by the solar wind. The full-scale picture, involving many field lines merging at once around the head of the magnetosphere, is akin to the outer layers of an onion being opened up in front and elastically peeled back, one by one, over the onion to the opposite side. The result of this magnetic merger is that the magnetotail gains magnetic and plasma energy at the expense of both the head of the magnetosphere and the surrounding solar wind, the tail field is intensified, and the plasma sheet is enriched and compressed.

A substorm breaks loose when the magnetic tension in the tail reaches some critical limit. A second magnetic merger then appears to take place—another field line reconnection, in which "hands change" back again. It seems to happen a short way back in the tail. Somehow, the magnetic field nearly disappears along a line directed across the magnetotail, in the plasma sheet. Along this "neutral line," field lines from the northern oval break and reconnect with their southern counterparts.

This rift zone is highly unstable, with field lines on each side suddenly bent double in opposite directions—two electromagnetic slingshots back to back, one aimed tailward into space, the other at the Earth's "backside" away from the sun. The pent-up magnetic stress releases as the two magnetic slings speed apart, creating powerful electric fields which shoot the trapped plasma in opposite directions. Some of the forward-beamed plasma spirals down magnetic field lines into the atmosphere to produce an auroral light show; this is accompanied by a "hot" return current of energized plasma from the ionosphere up to the radiation belt. The rest of the forward-beamed plasma is shot across field lines into the heart of the magnetosphere, where it joins the ring current; then it, too, diffuses into the surrounding radiation belt. Further earthward diffusion may warm the upper atmosphere.

Barfield studies the substorm by way of its magnetic effects. He monitors the snap of the slingshot with magnetometer data from NOAA's geosynchronous satellites in earth-stationary orbits over equatorial South America; he sees ring current effects from the satellite magnetometers and from mid-latitude ground magnetometers in the Americas and the Pacific; and he collects evidence of particles shooting along field lines from auroral belt magnetometers in Canada and Alaska.

This network of ground-based magnetometers is one of several around the globe that is specifically dedicated to IMS research. However, many stations of this trans-American network have special value to investigators like Barfield: not only are they well-located for correlative studies involving the geosynchronous satellites, their data are acquired digitally and relayed to SEL by way of these same satellites within minutes.

This gives Barfield a jump of several months over methods of years past. Furthermore, since data from these stations are available on magnetic tape rather than in graphical form, they can be readily processed by computer and automatically plotted to common scales of time and magnitude —a saving of many days of tedious and costly manual data handling.

Since the data reach SEL within minutes, researchers like Barfield will share them with the solar-terrestrial forecasters of SEL's Space Environment Services Center (SESC), and the computerized Data Acquisition and Display System will automatically present data from each IMS chain of stations together, in easy-to-use stack-plotted form. The forecasters will use the data to improve the substorm alerts and generalized prediction of magnetic activity that they issue to their regular scientific and commercial customers.

Meanwhile, Barfield puts the ground and satellite data together to see what new things he can learn about substorm dynamics. His immediate goal is to understand the field-aligned currents of charged particles that flow along the open field lines between the magnetotail and the auroral oval. Using both satellite and ground data, he has traced substorm currents from a point near their nightside, plasma-sheet source region to their earthward limit. There they drive the auroral electrojet, a concentrated ionospheric current that flows along the oval during auroral displays. It is the electrojet that produces the strong magnetic disturbance that high-latitude IMS magnetometers measure at the ground at these times.

SESC now uses the IMS magnetometer data to prepare a catalog of substorm events which is mailed to about 950 subscribers as part of that facility's weekly summary of solar and geophysical data. Forecasters and other users will have prompt access to the real-time data when its hookup to the SEL-DADS system is completed this fall, following a long and arduous debugging period. Barfield for one, hopes that the real-time data flow will outlast its scheduled January 1980 cutoff date. "The IMS data system gives us, for the first time, the ability to monitor in depth, and perhaps eventually to predict in detail, catastrophic magnetic disturbances in our near-space environment," he says. "If the system is shut down, we lose that capability."

All of SEL's magnetospheric research is being supplemented this year by preliminary work relating to a goal that is central to both SEL and the IMS: to describe and explain atmosphere-ionosphere-magnetosphere interactions. Dr. David Evans is spearhearing this effort to develop a cooperative research program with other groups and to define SEL's part in it. "No longer can researchers afford to study these areas as separate entities," he says. To underscore his point, he "collects" interactions. A good example is the 100-meter-per-second (223-mile-per-hour) wind that NOAA scientists observe at about 300 kilometers (186 miles) above Boulder, about 12 hours after Canadian auroral displays. "Magnetospheric processes simply dominate the Arctic atmosphere above 95 kilometers (59 miles)," says Evans. "They pump 1,000 times more energy into it than solar radiation does." And it works the other way too. He estimates that 70 percent of the electrons in parts of the outer radiation belt have come up from the atmosphere.

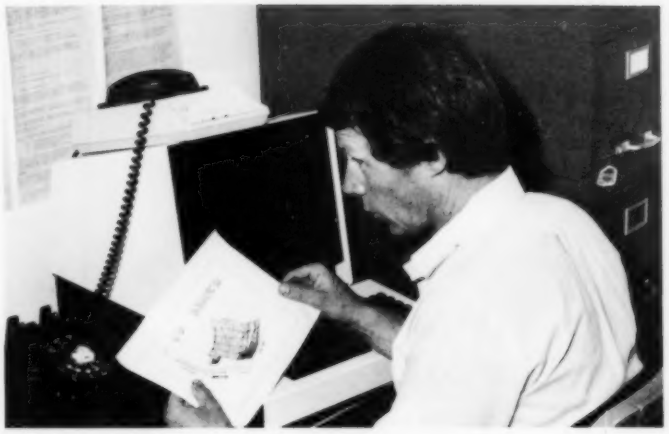
The kind of planning that Dr. Evans is engaged in is helping to pave the way for the overall success of the IMS. Although the observational stage will terminate at the end of 1979, the analysis stage, where the payoff lies, will continue into the 1980's. Scientists realize that the push to integrate and interpret this huge mass of data must be as strong and well-organized as the push to collect it.

The man who keeps his finger on the pulse of IMS research in this country is SEL's Dr. Robert Manka. He helps dozens of groups to coordinate their work. On the Federal level, these groups include not only NOAA, but also the National Science Foundation, National Aeronautics and Space Administration, U.S. Geological Survey, and Department of Defense. Though employed by SEL, Dr. Manka is detailed to the National Science Foundation in Washington, D.C., where he serves as U.S.-IMS Coordination Officer. His office, jointly sponsored by NOAA and NSF, acts as a focus for planning and coordinating the national IMS effort. Manka tries to see that the contribution of each group becomes an integral part of that effort. When not busy coordinating, he reverts to the role of investigator by actively participating in IMS data analysis workshops.

On the international level, Dr. Manka acts as a point of contact with scientific bodies and other countries with IMS programs. When he wants to exchange information on a global scale, he, like his counterparts in other nations, turns to the central IMS coordinator, NOAA's Joe Allen of the National Geophysical and Solar-Terrestrial Data Center. Allen is Chief of the Data Studies Division, and also heads up the IMS Central Information Exchange Office.

Allen edits the IMS Newsletter, a 10- to 12-page monthly summary of IMS operational messages and highlights with an international circulation of about 2,100 copies. Scientists the world over use the newsletter heavily for information exchange. It's an attempt to let everyone in on what everyone else is doing. "Our coordination is passive,"

Drs. David Evans (left) and Larry Lyons receive an award from ERL Director Dr. Wilmot Hess for their paper on the magnetospheric ring current.



SEL's Dr. Joe Barfield looks at computer-produced three dimensional plot of IMS magnetic data during a visit to the data center.

says Allen. "The information office has zero authority. Our philosophy is that if all the information is passed along, everyone will recognize the importance of working together voluntarily to accomplish common goals." To everyone's delight, this approach is working well.

An organization that gets lots of newsletter coverage is the Satellite Situation Center, a new tool for coordinating spacecraft observations with other types of data. The Center is a computer-based facility run by NASA's Dr. James Vette on behalf of World Data Center-A for Rockets and Satellites in Greenbelt, Md. It supplies the global IMS community with actual and predicted satellite orbits, specifies times when satellites will pass through particular magnetospheric features, and identifies periods when a satellite will be in the right position to coordinate its observations with those being taken elsewhere, aloft or at the ground. This kind of service helps scientists to make the best use of their IMS resources.

The information center and the satellite situation center were set up within their respective World Data Centers at the urging of the IMS steering committee, an international group established by the Special Committee for Solar-Terrestial Physics of the International Council of Scientific Unions. It was this Council that recommended the creation of the World Data Centers and established the guidelines for running them.

Supplementing the newsletter as a two-way channel for IMS information is the Space Environment Laboratory communications center. Its special telephone and telegraph facilities brought Allen prompt word of GEOS-1 satellite launch problems and helped him to relay early results of European rocket probes to a cooperating United States scientist just minutes after launch time.

The "Comm Center" is a part of the Space Environment Services Center, which is a source of timely IMS news items in itself. Whenever a solar flare breaks loose, which happens more frequently now that the 11-year cycle of solar activity nears its peak, Allen gets the story from SESC's forecasters—then he may use the Communication Center facilities to phone or telex summary information to experimenters, project scientists, and satellite controllers for ISEE, IMP, Voyager, GEOS, and others. On the basis of this tipoff, some spacecraft experimenters may decide to collect data at a higher rate over the next several days, in order to monitor the X-ray enhancement, the proton shower, and the magnetic storm. Later, back in his office, Allen writes up the details of this IMS event for his readers.

Joe Allen, at the computer terminal, types up the latest edition of the IMS Newsletter.

The IMS Information Office was originally a temporary, one-man, part-time show. After the first newsletter came out in January 1976, Allen recruited a helper—an older "940" computer, some three miles away, that he ties into from his office terminal. He uses it to store information and to tailor the newsletter text to fit neatly around the illustrations. It also comes in handy for adding or changing information at the last minute, and he can easily retrieve information from past issues by cueing the machine with the name of a particular scientist or project. "The 940's a clunky old beast, but very good for this kind of work," he remarks. "And there's no way we could do the job without it."

Those early months were hectic ones for Allen, but confirmation of the publication's value came soon, at a meeting of the IMS Steering Committee in Moscow. One of the Soviet representatives held up a copy of the newsletter and is reported to have said, "If this is what you mean by international program coordination, then we are for it." The Soviets have since remarked that the flow of IMS information represents a notable improvement over past programs in which they have participated.

In 1977, the Information Office achieved permanent status and became a truly international effort—top-notch U.S. and foreign scientists were assigned there on a rotating basis, one or two at a time. Japan, Italy, Australia, and NASA have each sponsored a scientist, and Great Britain, the Soviet Union, and West Germany may follow suit.

Although the Information Office fits neatly into the IMS picture, what about the role of its parent organization, World Data Center-A/Boulder? How does it mesh with international, space-oriented programs that produce great amounts of digital data? Part of the answer lies at the Space Environment Laboratory, one of the places where the meshing process begins.

Raw, uncorrected data are now streaming into SEL from three sources: magnetic observations from the IMS trans-American magnetometer network, magnetic and particle data from ISEE satellites 1 and 2, and magnetic, particle, and X-ray data from two of NOAA's five geosynchronous SMS/GOES satellites. In addition, data from the polar-orbiting TIROS-N satellite will be available this fall. As a result of this heavy data flow, SEL has an impressive data library of its own, filled with some 16,000 tapes of data in various stages of editing. The Lab also has an Analysis Group, one of whose jobs is to make this incoming raw data research-ready and send it on to the archivers.

Coming Up:

Project Earthspace

Dr. Donald Williams, Director of the Space Environment Laboratory.

Even as the IMS continues, a solar-terrestrial program for the 1980's is being planned which encompasses not just the magnetosphere, but all of Earthspace. This region, according to SEL Director D. J. Williams, extends to "distances where interplanetary measurements are not contaminated by magnetospheric output—distances of several hundred earth radii in the solar direction and larger, but as yet unknown, distances in the anti-solar direction."

The study's formal name is Origin of Plasmas in the Earth's Neighborhood (OPEN). The planning group was formed by NASA and is cochaired by Dr. Williams. Project Earthspace will supplement other programs that will carry on the study of the magnetosphere. Specifically, it will pursue the ways in which energy is transferred, stored, and dispatched throughout this greater region.

The primary medium in which all this energy resides is magnetized plasma, the two main sources being the solar wind and the Earth's ionosphere. Many processes act to modify these two source plasmas, to form a number of other plasma populations in and around the magnetosphere; these populations, most of which are referred to in this IMS article, interact to control the energy balance and dynamics of the Earthspace system. Many of the processes to be studied, such as magnetic field reconnection and acceleration of energetic particles, are also intimately related to central questions of space plasma physics.

These processes and problems will be studied with data from our satellites. They will be (1) an Interplanetary Physics Laboratory in a solar orbit near the libration point (on the sun-Earth line, where gravitational forces balance); (2) a Geomagnetic Tail Laboratory in a deep (150 earth radii, or more) tail orbit; (3) a Polar Earth-Orbiter; and (4) an Equatorial Earth-Orbiter.

Williams comments that one of the main problems to be studied has only recently been acknowledged to be significant. This is the matter of the impact of magnetospheric and solar-terrestrial processes on the entire atmosphere and on society. He anticipates that NOAA will have a major role in identifying and dealing with these effects.

Each data set has its down problems and they are often formidable. This is where the human faults and natural constraints that went into the production of the raw daa, from drawing board to final readout, all come home to roost; each one must be identified and dealt with. "Unfortunately, we're sometimes faced with terrible problems," says Tom Gray, head of the analysis group. He copes with these analytical nightmares by relying on the insights of the project scientists and the ingenuity of his programmers, and "by being edgy about letting anyone else dink with my data." Here, he refers to the editing out of features like noise spikes or sudden offsets.

"How do you distinguish between noise and real changes in the data?" Gray asks. "One person's noise may be another person's Ph.D." Accordingly, he insists that a knowledgeable scientist be assigned to work with him on each new data set, to help bring it up to archival quality. After this job is done, data tapes are sent to the archivers, primarily World Data Center-A/Boulder.

World Data Center-A, on the receiving end of an exponential upsurge of solar-terrestial data, in addition to its solid-earth and glaciology responsibilities, is no less challenged than SEL. Alan Shapley, head of NGSDC and WDC-A/Boulder, has stated that large-scale geophysical programs "have combined to unleash a flood of data from which we (the various U.S. data centers) have not recovered." The centers have millions of feet of magnetic tape and of film records, and millions of cubic feet of paper documents; and their inventories continue to rise dramatically. Add to this storage problem the function of reproducing data in other convenient forms and preparing inventories, summaries, and syntheses, all in the face of budget and staff constraints, and you have an almost overwhelming situation.

In spite of all this, the IMS scientist in need of observations continues to be well served. Scientists are invited to the Center to preview data, perform preliminary analyses and define precisely the minimal needs of their home institution. If the observations being sought are not on file there, the Center will act as a broker between seeker and collector.

Sometimes the Center goes shopping for data, too. In early 1976, Joe Allen visited the U.S.S.R. to talk about trading IMS observations. He took sample data tapes with him to World Data Center-B in Moscow. Unfortunately, the format of the tapes was incompatible with their computers. But Soviet data were recorded on the tapes, which were then returned to Boulder for analysis. From this shaky start, and subsequent visits of Soviet data center staff to the United States, an exchange of digital magnetic tapes has developed. Reasonable growth of this exchange into a routine operation seems likely.

Next spring, Allen journeys with other IMS scientists to World Data Center-C in Tokyo. There, they will study selected intervals when unusual phenomena occurred, as they have done at other workshops over the past two years. In the words of the workshop chairman, Dr. T. Obayashi, "This organized campaign to study the physics of the outer envelope of our planet has already produced a wealth of new information and is proving to be a most successful international project."

The success of the IMS goes beyond the science of it. There is some real feeling that in spite of continuing world tensions this kind of international cooperation is helping to lower a few barriers. Joe Allen, whose IMS travels have taken him throughout Europe—including two weeks as a guest of the Slovak Academy of Sciences—tells of two Soviet scientists who visited his home while working at the Data Center.

"They left us a children's book about a young Soviet hero who goes on to become a great producer of robots—an unusual book by American standards, but the kids got a kick out of it." In the front of the book, one of the visitors had written, "Here's in hope that our children and your children will live in peace with one another as the result of our efforts."

Although there is a realistic limit to Allen's optimism, he fully shares the expectation of IMS Chairman Roederer that even after the international spotlight withdraws from the magnetosphere, the scientists involved will continue working together as "colleagues and friends across boundaries of any kind." □

In The Wake Of The Ancient Mariner

Nautical Archeologists Probe Ancient Cultures

By ANN GREER

FOR A CAREER of astonishing variety, consider the young science of nautical archeology.

On a given day, a nautical archeologist might switch between reading ancient Greek and designing a better decompression chamber. Engineers, physicists and oceanographers join forces with artists, historians and architects in pursuit of this fascinating profession. It is, according to George Bass, one which combines the talents of the scientist and the humanist; it is the most multi-disciplinary field in all of ocean science.

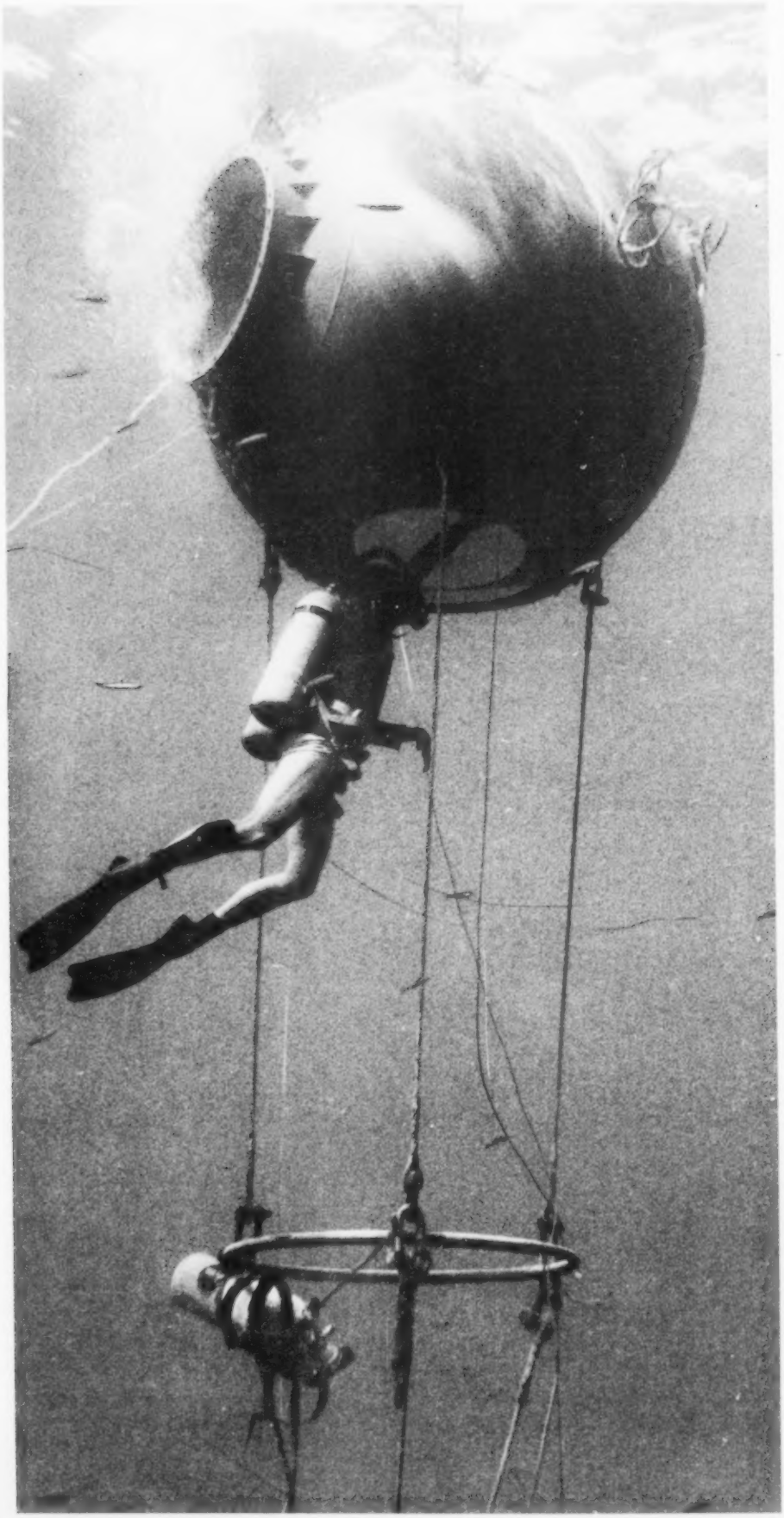
Dr. Bass is a classical archeologist educated at Johns Hopkins and the University of Pennsylvania and affiliated for several years with the latter school's University Museum. He and his associates have worked for the past 20 years to establish nautical archeology—the study of ancient ships and their cargoes—as a truly scientific discipline.

It hasn't been easy; fellow humanists and scientists have been skeptical. But a giant step was taken in 1976 with the establishment of a master's degree specialization in nautical archeology and a permanent home for the non-profit Institute of Nautical Archaeology at Texas A&M University.

This year, Bass and his colleagues have been brought into NOAA's Sea Grant network, with a grant award through Texas A&M. Projects include a student training excavation of a vessel in Texas, plans for a full-scale model of a Greek ship, and a film library of excavations from around the world.

Nautical archeology is a logical component of the study of ancient civilizations. Fishing boats, ferries, warships, pleasure craft, and merchant ships provided the major means of transportation and the interchange of ideas and goods between cultures. But less is known about the development of ancient seafaring than about weapons, coinage, or pottery.

According to Bass, nautical archeology got its first big boost in the 1940's with



Cousteau's improvements to the Aqualung. No longer would artifacts underwater be limited to chance discovery and retrieval by fishermen and sponge divers. Now, divers could work directly with the remains of a ship and its cargo.

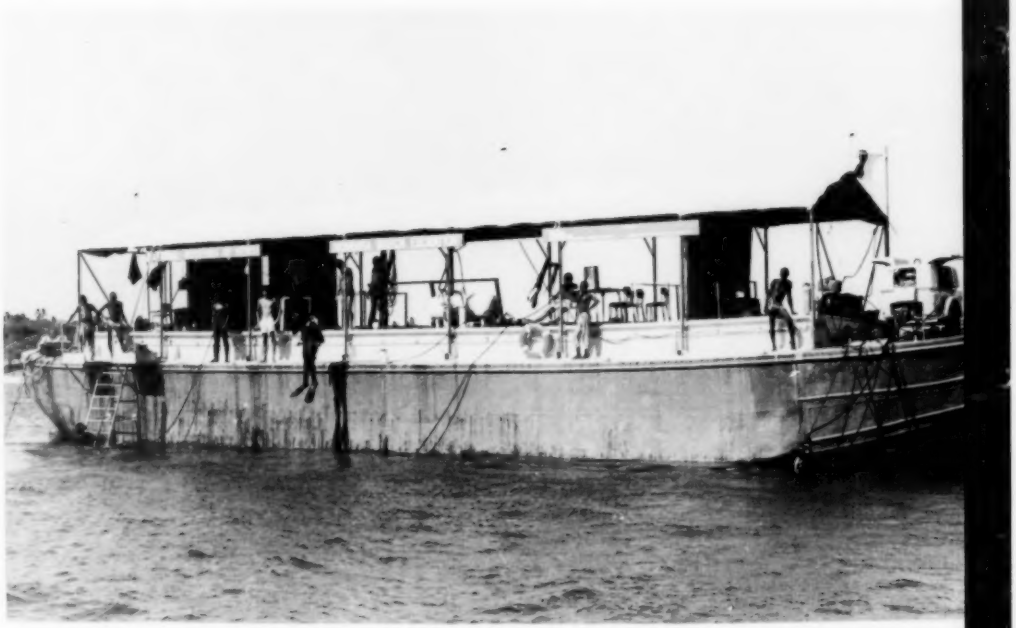
It was not until the 1960's, however, that archeologists took to the water. The result was the development of new methods for working and recording under water that have made undersea excavations as accurate as those on land.

Bass and his team tested the most sophisticated apparatus available for work beneath the sea. When a piece of equipment did not meet their special needs, they modified it or designed something completely new. A sample of the gear used in an undersea excavation includes:

- A basket with a lifting balloon which can raise up to a half ton of cargo from the ocean floor.
- A submersible, globe-shaped chamber, which is anchored with cables on a pulley and pumped full of air, provides a dry, warm place for divers to decompress. Besides allowing for a more comfortable decompression period than when divers hung from a line in cold water, this method makes possible longer decompression periods and thus longer dives.
- A stepped iron scaffolding installed over the wreck site supports a tower for taking photographs and divides the area into segments for excavation.
- A communications bubble located on the sea floor has a Plexiglas hemisphere containing breathable air pumped from a compressor on a barge above. Creation of this structure enables divers to talk with each other and to speak by telephone with someone on deck.
- A two-person submarine was engineered in 1963 to Bass's specifications. It was one of the first research submarines built and sold privately in America. Asherah, named for the Phoenician goddess of the sea, was used both by itself and with a side-scanning sonar unit in searches for new wreck sites. Asherah also was used for photographic surveys of a dig in progress, employing a photo-mapping method called stereophotogrammetry.

Before the refinement of the submarine, the stereophotographs had been taken by a diver who slid his camera along a metal bar which floated horizontally above the wreck. Notches at regular intervals on the bar indicated where each picture was to be taken. Pairs of photos could then be viewed through a stereoscope to yield three-dimensional observations of the wreck. This technique was a vast improvement over the earlier method of measuring elevations at hundreds of points by hand. But with Asherah, stereophotography that required less

After exploration of ship dating from fourth century, diver enters submerged decompression chamber. (Photo: John Cassils, Institute of Nautical Archaeology.)



From upper left: Dr. Frederick H. van Doorninck cleans remains of Roman ship hull, preparing for photography; Dr. George Bass, head of Texas A&M's nautical archaeology group; J. Richard Steffy works with students in ship reconstruction class; barge anchored off Mombasa, Kenya, served as operations base for excavation of Portuguese warship sunk in 1697. (Photos: Institute of Nautical Archaeology and KC Smith.)

than half an hour's work replaced a dozen archeologists on scuba working many weeks.

With all these innovations, Bass found in the late 1960s, while excavating a Roman wreck, that he was directing "the largest single diving project in the world." Nobody else—not oil drillers, Navy teams, salvage firms, or oceanographic institutes—had 25 divers working twice a day at 140 feet, six days a week, for months at a time, he said.

But Bass cautions against would-be divers with no interest in archeology rushing into the field.

"One thing we don't need is professional divers," he explained. "We teach inexperienced divers the fine points after they get to the wreck site. Ours is controlled diving —usually the water is clear and warm with no current, a barge is directly above the divers, and extra air is available. So almost anybody can stay down for 20 minutes and do their work."

Bass knows what he is talking about. No diving deaths have occurred during any of the projects he has been associated with, even after thousands of hours on the sea floor.

The 1970's have been devoted to learning about ancient wooden ships and harbors and to putting them in historical perspective. Emphasis now is on the ships themselves rather than on the techniques needed to locate and excavate them. More time is being spent studying how ships were built and designed in addition to studying their contents.

Why ships and harbors? The most obvious answer is that bodies of water, such as the Tigris and Euphrates, the Nile, and the Mediterranean and Red Seas, provided the primary means of transport for most ancient civilizations. These bodies of water made possible early migrations, such as those that populated Greece and Italy, and the dissemination of ideas like the alphabet and coinage. Empires rose and fell on the outcome of sea battles.

Ships have been navigating the Mediterranean for the past 10,000 years, even before domesticated animals and agriculture were developed. Wrecks found there and elsewhere are well preserved and protected from plundering by man. And, if the date of the wreck can be determined, the contents can be easily dated as well.

Bass says another good reason for studying ships is that they represent the best technology of the period. The shipbuilding craft always has been advanced because of the heavy cargoes that were carried on the often violent sea. So, sunken ships provide one of the best sources for the study of the history of technology.

A result of this concentration on ship technology has been the small-scale reconstruction of the wooden ships which have been excavated. These models allow study and interpretation from a three-dimensional perspective. A variety of hull replicas are constructed and tested, as well as models of anchors, rigging, and miscellaneous ships' fittings.

"Archeologists have overlooked ships," Bass said. "The reason Athens was great was because of its merchant marine. We know about clothing and coins from that period,

Above: Australian archeologist Jeremy Greene and Texas A&M student Sheila Matthews work on Portuguese warship off Mombasa; right above, Sheli Smith works on ship model; right below, Frederick van Doorninck reassembles ship's timbers. (Photos: Institute of Nautical Archaeology and KC Smith.)

but not ships."

Today, nautical archeologists are working in waters off four continents—Africa, Europe, North America, and Asia. They are excavating ships and their cargoes covering 3,300 years. Though different in content, each project goes through the same stages of development.

"First you have to find the place," Bass said. "In the Mediterranean, information on wrecks from sponge divers and fishermen is usually more efficient than sonar. Records and charts, on the other hand, help locate the more recent wrecks in the Caribbean and off Florida."

A site is chosen, based on preliminary findings of a unique cargo or because the wreck represents a period that is a gap in the understanding of ancient ships. A current excavation off the Asiatic coast of Turkey holds both allures—it contains a valuable cargo of ancient glass, and the medieval (11th century A.D.) hull appears to be built skeleton first in the "modern" way. This hull offers clues to the development of ship technology. An extra impetus was the relatively shallow 110-foot depth of the wreck.

Then come months of diving, mapping, and recording. Contents of the ship and segments of the wreck will be photographed and labelled on the seabed. Drawings, field plans, and notebooks must be precise, because the excavated objects remain in the country off which they are found. Bass estimates that the excavation phase of a project costs approximately $100,000, excluding salaries. Many of the staff are volunteers who work during the summer.

Years of library research by trained archaeologists establish the significance of any excavation. Bass and his associates are often able to establish a vessel's origin, its purpose, and ports of call, in addition to specific information about its contents.

"We are able to learn things from wrecks that we don't from land, and vice versa," Bass said. He bristles at the idea many have that nautical archeologists are primarily scuba divers. "People don't call land archeologists jeep drivers."

The Institute of Nautical Archaeology (INA), founded in 1973 by Bass and his associates, sponsors scholarly excavations and the dissemination of knowledge gathered from them. This 400-member organization is funded through private donations and annual contributions from 20 American universities and museums, including Scripps Institution of Oceanography, Yale University, and Cornell University.

INA projects have included location and excavation of the oldest ship on record (ca. 1600 B.C.) and restoration of the only Classical Greek ship in existence. The Institute also conducts international field schools with students ranging from advanced undergraduates to post-doctoral professors.

Nautical archeology is well on its way, thanks to Bass and his colleagues. The archeologist says he now spends about ninety percent of his time on administrative duties and the logistics of an excavation. But the rewards of this new discipline are many, and Bass wouldn't have it any other way. □

Hands-On Training For NOAA Corps Officers

By JOHN G. STRINGER

At the southwest tip of Cape Cod, Mass., lying between Buzzards Bay and Vineyard Sound, is the town of Woods Hole, a busy commercial center and a transshipping point for passengers and freight to and from Nantucket and Martha's Vineyard.

Woods Hole is the home of NOAA's Woods Hole Laboratory, the world's oldest fisheries research facility and second oldest marine biological station. It also is the home of the NOAA *Albatross* IV, a 187-foot fisheries research vessel captained by Walter Beatteay. On June 5, 1978, he leaned over the bridge rail on the port side and watched as six NOAA Corps officers walked up the aft gangway and boarded the ship.

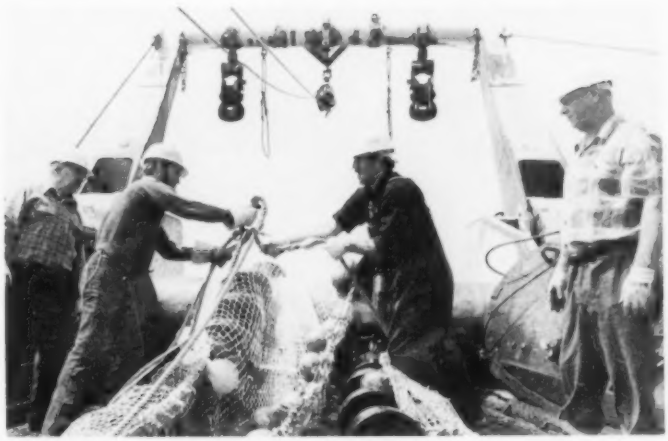
It was a chilly morning; the wind was from the south and had a hint of rain in it. The white ship, moored at the foot of Water Street, gleamed momentarily in her shroud of dew when a hazy sun glimpsed through the blanket of drab gray clouds hovering far above. Accompanying the six officers were Cdr. M. H. Fleming, officer-in-charge of NOAA's Northeast Marine Support Facility, and Earl Rayfield, coordinator of the 3-week course in fisheries technology conducted by the Office of Fleet Operations of the National Ocean Survey. The six officers were beginning the last of the program's activities.

The purpose of the specialized training course is to provide NOAA officers with exposure to actual fishing operations and familiarization with the fishing industry prior to their assignment to fishery related seagoing or shore billets. Training is directed toward the practical aspect of fishing vessel operation including introduction to, assembly, and at sea use of fishing gear—primarily trawl nets. Lectures and films are presented covering a broad spectrum of subjects, and field trips are arranged to local NOAA installations and commercial fishing activities.

"To be considered for this training," said

Lead Fisherman Nick Vadala (right) barks "over the top and take two turns" to Lt. (j.g.) Herbert Kirch as he prepares to use the capstan to haul the net aboard. Skilled Fisherman Cyril Lundrigan (top right) holds the net while Lt. Roddy Swope dumps the catch.

assignment: fisheries



The trainees (top left) listen as Lead Fisherman Vadala (far right) describes the operational characteristics of the net before the Albatross IV (below left) gets underway.

Lead Fisherman Tom Frontiero (top right) explains the trawl house operation to Lt. Roger Mercer. Officers take a "bight" (below right) on the net under the watchful eye of the instructors. Left to right: Lead Fisherman Vadala, Lt. (j.g.) Bryce Scott, Lt. Swope, and Skilled Fisherman Lundrigan.

Rayfield, "an officer should have completed one tour of sea duty and be a qualified Officer of the Deck—Underway."

The training begins at the University of Rhode Island's Department of Fisheries and Marine Technology at Wickford, where the first course in ship's operations and fisheries training for officers was set up in 1972 after the merger of fisheries ships into the NOAA fleet.

"A wholesale effort was launched," said Rayfield, "to find an institution that could provide a program in the fishing operations."

The University of Rhode Island was selected, and continues to provide the training, which is constantly being refined in response to critical evaluations submitted from each class participant.

On Sunday, May 14, the six officers arrived at Wickford where they rented a house for the training period. Making up the complement were Lt. Cdr. Robert K. Norris of the NOAA ship *Kelez*, Lt. Gary M. Albertson of NOAA's Pacific Marine Center, Lt. Roger W. Mercer and Lt. (j.g.) Herbert N. Kirch of the NOAA ship *Miller Freeman*, Lt. Roddy S. Swope of Environmental Research Laboratories, Juneau, Alaska, and Lt. (j.g.) Bryce M. Scott of National Marine Fisheries Service, Southeast Fisheries Center, Galveston, Texas.

"The house was no more expensive than a motel would have been," said Rayfield. It would provide them with an opportunity to exchange ideas and to have group discussions because the "backgrounds of the officers in every class are as different as their assignments."

Orientation was held the next morning at the University's Wickford Fisheries Laboratories. Project Director John C. Sainsbury welcomed the trainees, and 30 minutes later the group was viewing a film on the art of bottom trawling on a stern trawling vessel.

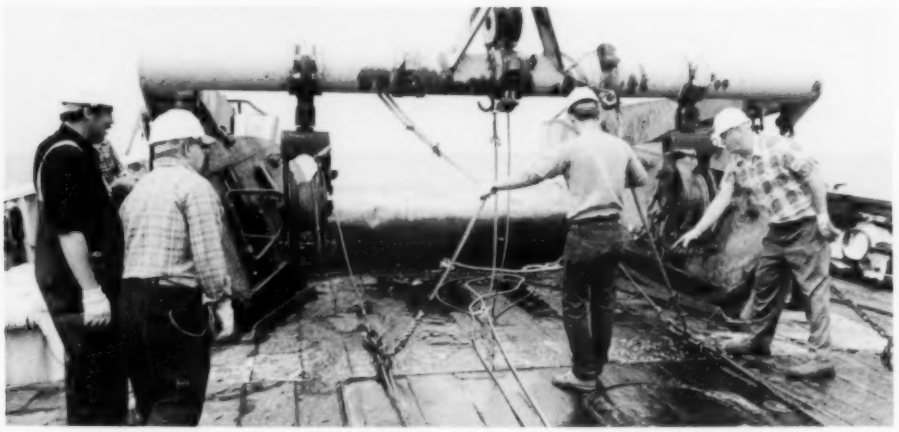
Sainsbury, who conducts classes in stability, powering, and drag coefficients on nets, is a graduate of a major British university specializing in marine naval architecture. He is supported by Professor Albert Hillier, a fisherman from Newfoundland with some 35 years experience, who explains what is required in the construction and design of nets, the rigging of fishing gear, and rimracking, which is the untangling of nets snagged on such things as a large anchor.

"Professor Hillier can teach our fellows," said Rayfield, "how not to rimrack, and how to get out of a rimrack once you get into it."

Lectures and films include a broad spectrum of subjects, such as U.S. Fishing Operations and Industry, Fishing Techniques and Equipment, Bottom Trawl Design and Construction, Techniques of Net Mending, Rules of the Road—Fishery Vessels, Fishing Vessel Technology-Design, Stability, Propulsion, Deck Machinery, Rigging, and Safety, Electronics in Fishing, Rope Technology, the Fisherman's Rigging, and Safety, Electronics in Fishing. The Fisherman's Viewpoint, World Fisheries, and Problems in Trawling.

A third member of the small academic circle at Wickford is Professor George Gamache, a graduate of the University who is presently working on his master's degree.

First Mate Joe Miller (top right) describes the handling characteristics of the Albatross IV to Lt. Cdr. Robert Norris while Capt. Walter Beatteay (below left) relaxes for a moment during a mid-day break in the training cruise routine. A coordinated effort by all officers results in a perfect set (above right) of the 68-foot trawl net.



Lt. (j.g.) Scott (top left) operates the trawl winch under the supervision of Lead Fisherman Vadala as Lt. Swope (top right) plots the ship's course. It's "hands on" (above) when orders are given to hook up the trawl to the gantry.

A native of Point Judith, R.I., who has fished all his life, Gamache offers a blend of academic approach with what Rayfield calls "hands-on" training.

That afternoon the officers boarded the University's fisheries training vessel, *Gail Ann*, on which they practiced what they had learned that morning. During another day of hands-on training aboad the ship, the officers participated in the rescue of two men stranded in a small boat six miles out in Narragansett Bay.

The weather had been unsettled, and small craft warnings were up. The men had been fishing when their boat ran out of gas, and they were frantically waving for help when the officers aboard the *Gail Ann* saw them. They hauled the two men aboard, took their small boat in tow, and steamed back to Wickford.

An integral part of the training program is its field trips. First is a fish auction, where the officers learn what a commercial fisher does with the catch made on a fishing operation. Following one of the purchases from the auction to the local processor, the officers don white coats and hats to go into the processing room. They watch the boats being unloaded, and the weights being taken of each box to verify the size of the catch. The fish are cut into fillets, either manually or through machines, or skinned by machine, to a wash-up process, and then put into packages which are frozen.

The officers visit a vocational high school in Fairhaven, Mass., where students are trained to enter the fishing industry. They also visit a whaling museum in New Bedford, Mass., a net-making company, and a rigging shop where fishers go to have their cables spliced and anchor lines made up. Finally, they stop at the local supply store, the supermarket for the fishing industry. "That store sells everything needed for the fishing boats," said Rayfield, "—bait, hooks, gloves, boots and weather gear, potatoes, magazines, the whole bit."

Although the Rhode Island fisheries training program was established primarily for officers of the NOAA Corps, civilian employees also may apply for the course. Several years ago, Scott McKellar, a marine specialist for the National Ocean Survey, signed up and journeyed from Rockville, Md., to Wickford.

"One of the requirements of the course," said McKellar, "is that the student knit their own hammocks and construct a 35-foot bottom trawl net."

McKellar, who made three hammocks during the 3-week period—a record which remains unbroken—said, "If the students are eager, as most of them are, they prefer to work at night to get the hammock and net made, and to get on to another project."

According to Rayfield, the hammock is the only way to sleep at sea. "It works on the pendulum principle," he said. "The ship moves and you don't."

Underway at 0700, the *Albatross* IV pulled slowly from the pier into Great Harbor and headed south between Great Ledge and Nonamesset Shoal into Vineyard Sound. Because of the forecast for poor weather, no pleasure boats were seen on the Sound. Ahead were two small commercial fishing boats which veered easterly toward Nantucket past Nobaska Point.

This was the final day of training for the eighth class of NOAA Corps officers gathered on the stern to be introduced to the ship's fishermen who would be their instructors in vessel operation, fishing, and repair of nets and gear. Each member was assigned duties of bridge officers or fishers under the supervision of the ship's personnel assigned to that task.

"This is a training program," Rayfield told the officers. "It is important that you receive advice from the crew members at each station. After two sets and haulbacks, you will rotate positions. Catches are not important so length of tow can be as short as five minutes."

When the *Albatross* IV returned to Woods Hole late that afternoon, the officers had conducted more than 12 sets and haulbacks in Vineyard Sound. Their training was completed in the practical aspects of fishing vessel operations. □

By LT. DANE VOSS*

On Board At NMFS

THE TRAWL DOORS BROKE the surface and ground slowly into position on the aft quarters of a fishing vessel barely making way under the gray Gulf of Alaska sky.

"Bridge, this is the trawl house, trawl doors coming in." The conning officer advised the bridge from his station in the small house perched over the vessel's after deck.

"Good," came the reply from the speaker, "There's a string of crab pots about a mile and a half dead ahead." The trawl winch continued its noisy retrieval with only a brief pause as the doors were locked in place.

"Nets in sight, looks like a good haul. Want me to come left a bit to miss those pots?"

"No, we'll be okay."

Soon the trawl net crept onto the wet deck and the noise from the winch changed pitch slightly from the weight of the catch.

"Catch is on the deck. I'll shift the con back to the bridge."

"Roger, let me know when we can get underway for the next station."

The straining rattle on the winch abruptly stopped and was exchanged for the buzz of electric motors as the after boom was swung in position over the net. Deft hands passed a line around the net and hooked it over the boom cable. A nod from the fisherman on deck and the net was lifted aloft and slowly guided over a large wooden collection box. A few tugs on the rope securing the cod end and five tons of Alaskan pollock and yellowtail flounder tumbled into the box.

"That's it bridge, let's get underway." Closing the door behind him, the ship's officer climbed down the ladder to help process the catch.

These fish will not be processed for commercial operations, however. Instead they will be sorted, weighed, and measured by the scientists and crew on the NOAA fisheries research vessel *Miller Freeman* as part of a resource survey and population dynamics study being conducted by the National Marine Fisheries Service, Northwest and Alaska Fisheries Center.

In a Seattle fisheries laboratory 1000 miles away, Joanne Parker is recording behavioral observations on a species of flatfish similar to that just caught on the *Freeman*.

I asked her the purpose of her research.

Resting her clipboard on the side of the tank, she gave a brief explanation. "The

Lt. Joanne Parker, top left, examines a starry flounder undergoing hormone injections that will alter the spawning time. Lt. Dean Mericus, left, examines catch in an experimental shrimp trap. Lt. Cheryl Cavin, above, prepares to gaff a shark during experiments conducted off New England.

**Lt. Voss of the NOAA Corps is now detailed to NMFS headquarters*

Lt. Cdr. Ronald Smolowitz and commercial fisherman Joe Testaverde weight cod during mesh trials aboard Gloucester dragger Linda B. (Photo: Gloucester Times)

water and sediment in this tank have been contaminated with a low level concentration of crude oil, such as might be found in the immediate vicinity of an oil refinery. I'm comparing the behavior of these fish with those in the control tank." She motioned toward an identical tank standing close by. "We periodically dissect the fish and analyze the tissue to check the amount of oil ingested."

"The behavior patterns we observe give us insight into the fingerlings' ability to feed and avoid predation while stressed with this level of contamination. With this information we can predict the effect of chronic exposure to low level oil pollution on immature flatfish and, eventually, how this will affect the population of the mature fish stocks on the high seas."

The project that Parker explained and the related work being done on the *Miller Freeman* are part of a National Marine Fisheries Service program to develop, conserve, and manage the living marine resources of the United States, and contribute to the overall NOAA objective for a cleaner and more productive ocean environment. While the similarities of objectives are obvious, these particular projects have something else in common. The skipper and mates on the *Miller Freeman* and the scientist in Seattle are all officers of the NOAA Commissioned Corps.

The integration of Corps officers into the National Marine Fisheries Service began seven years ago, soon after implementation of Presidential re-organization plan number four in 1970, which created the National Oceanic and Atmospheric Administration. Since that time, Corps participation in NMFS has increased, and the Director of the NOAA Corps, Admiral Harley D. Nygren, hopes Corps officers will be able to make a greater contribution to fisheries programs in the future. At a recent meeting between Admiral Nygren and Terry Leitzell, assistant Administrator for Fisheries, Admiral Nygren said, "I would like to see us develop a group of officers within the Corps who have competence in the living resources programs and who can perform for NMFS much as the officers serve NOS and ERL. I think we have made a good start toward this, and hope the interaction of Corps officers with fisheries will continue to grow."

A visible Corps presence has been established in the Fisheries Service, but the interaction has been somewhat slow in development. Perhaps this has been due to the vast difference in the origins of NMFS and the Commissioned Corps.

The evolutionary process leading to the present National Marine Fisheries Service began in 1871 when President Ulysses S. Grant signed legislation establishing a U.S. Fish Commission. In the beginning, the entire commission was composed of one man and had the responsibility to "ascertain whether any and what diminution in numbers of food fishes of the coasts and lakes of the United States had taken place; and, if so, to what causes the same is due; and also whether any and what protective, prohibitory or precautionary measures should be adopted."

In 1956 the Fish & Wildlife Act created the Bureau of Commercial Fisheries (BCF) within the Department of the Interior. BCF remained intact for fourteen years, developing into an organization with nearly 30 major laboratories and centers. In 1970 this organization was combined with others, to form NOAA in the Department of Commerce.

As the Government's fisheries programs were evolving, so too was the Commissioned Officer Corps. May 22, 1917 is recognized as the official birthdate of the Commissioned Corps, but the history of the Corps actually

begins in 1807. At that time, President Thomas Jefferson, responding to the need to update Pre-Revolutionary War British Admiralty charts, signed into law an act to establish a federal agency to survey the coast of the United States and publish charts, tidal data, and other material required to permit safe navigation of vessels along the coast. This agency became known as the Coast Survey, later the Coast and Geodetic Survey. In the early days the Coast Survey depended heavily on assistance from Army and Navy officers who had prior experience in surveying and hydrography.

Eventually all military presence in the Coast and Geodetic Survey was withdrawn but the civilians who operated the survey ships and directed field survey operations continued to be referred to as field officers, and in fact continued to wear maritime uniforms and maintain military-like lines of authority in the field and on board ships. The intervention of World War I prompted passage of the Act of May 22, 1917 to allow the President to appoint the "Field Officers of the Coast and Geodetic Survey" commissioned officers, and to allow emergency transfer of ships and men to the Navy in the event of war.

When NMFS and the Commissioned Corps came together in the NOAA family, NMFS had a background of biological research, and the Corps traditionally had been composed of hydrographic and geodetic engineers. How could these two elements fit together?

At the time of the formation of NOAA's predecessor ESSA—the Environmental Science Services Administration—in 1965, the Corps had found it desirable to change its recruiting practices. Until then, officers had to have degrees in engineering. To embrace its increased field of activities the Corps began recruiting candidates with physical and life science degrees, including biology. Thus began a quiet transformation from a civil engineering organization to a multidisciplinary scientific corps. When the NOAA Commissioned Corps was established in 1970 a sufficient number of officers with credentials attractive to NMFS were already available for assignment to fisheries programs.

The placement of Commissioned Officers in NMFS began in 1971. As of this writing, there are 29 Corps officers working in fisheries laboratories, and another 20 provide direct support to fisheries programs through assignments on various fisheries research vessels. The total represents a sizable percentage of the existing total Corps strength of 367 officers. By comparison, National Ocean Survey (NOS), the traditional area for Corps assignments, has approximately 70 shore based officers and the Environmental Research Laboratories (ERL) have 40.

Lt. Douglas Hennick fills baskets with fish to be sorted for species composition studies during his 60 day tour as an observer on the Japanese mothership Koshima Maru.

The method of making the initial introduction of officers to fisheries programs was established by Admiral Nygren. In order to develop the desired "cadre of fisheries officers," he felt that an organized progression of assignments would be necessary. Initial shore assignments are made by matching individual officer interests with the expressed needs of the laboratories. At the completion of this assignment, two to three years, the officer rotates to a fisheries related seagoing billet, and at the end of this tour, back to the fisheries center for another shore based assignment.

At this point, only a few officers have been in the fisheries program long enough to make this complete circuit. But these officers, such as Ron Smolowitz, Michael Kawa and Kurt Gores, demonstrate that Admiral Nygren's plan to enable NMFS to take full advantage of Corps officers is working quite well.

assignment: fisheries

Lt. Dean Mericus prepares shrimp trap for one of the experiments conducted by the NMFS Miami laboratory.

The bulk of the officers in NMFS are still working in their first assignment to fisheries. These assignments cover a wide spectrum of disciplines from marine mammal research to budget analysis and are located in all areas of the United States. The Northeast Fisheries Center in Woods Hole has six officers assigned to various projects and is a good example of the diversity of assignments given to Corps officers by NMFS.

Two officers, Lt. Tom Meyer and Lt. Charles Gross, are involved in the Center's diving program, providing operational diving support to several projects. Lt. John Moakley will report to the Center's Gloucester Laboratory later this year working as a mechanical engineer on inshore fisheries gear development, and with additional duties including the piloting and maintenance responsibility for a 65′ fisheries research vessel.

In contrast to these assignments, which are basically operations related, Lt. Cheryl Cavin and Lt. Bob Pawlowski are working as research assistants in two Center programs. Cavin is assigned to the Narragansett Laboratory assisting with the collection and analysis of shark research data. Working essentially as an independent researcher, Pawlowski collects and analyzes data relative to the physical processes that affect biological productivity in the Middle Atlantic Bight and the Georges Bank-Gulf of Maine area.

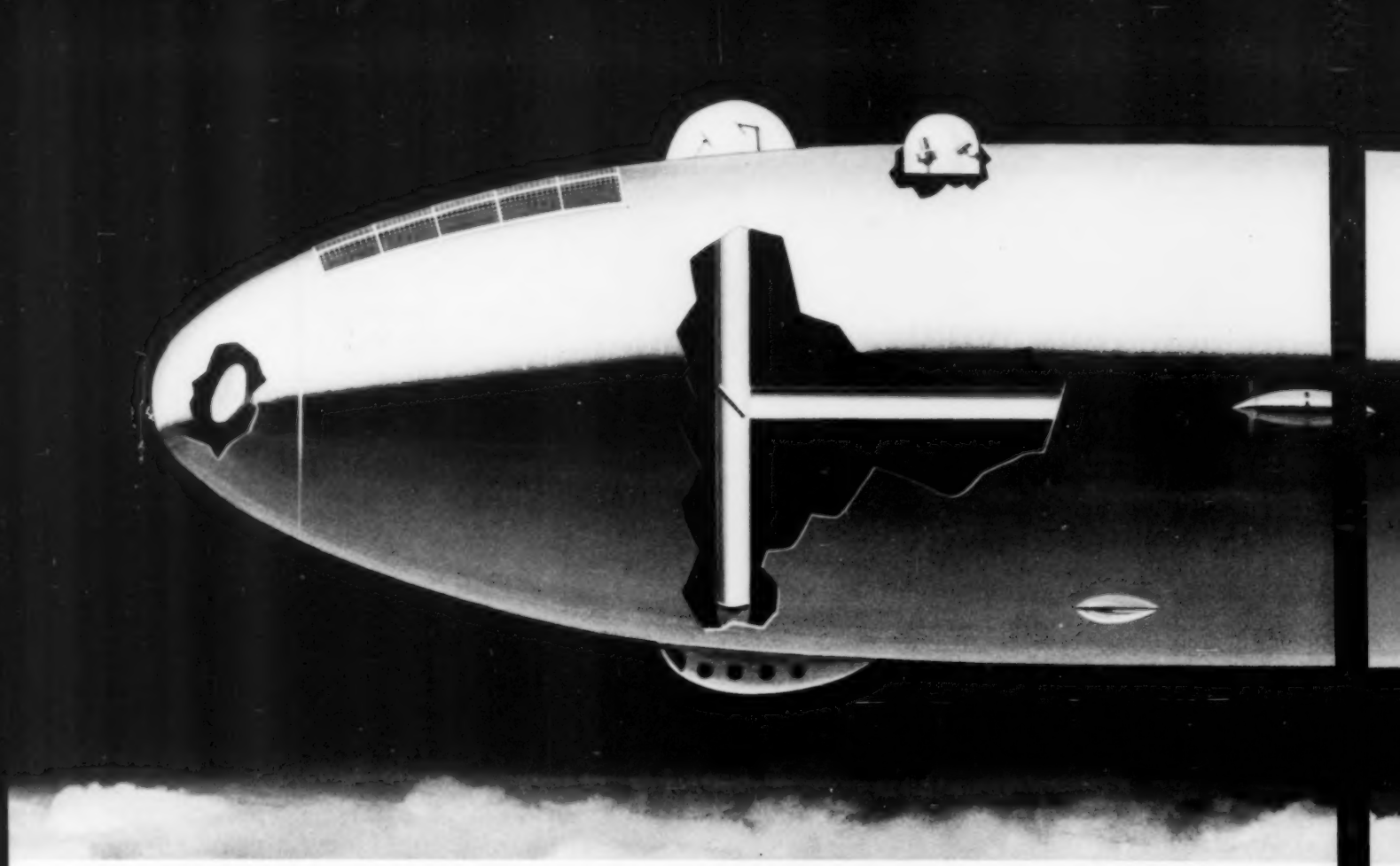
The sixth officer assigned to the Northeast Center is Lt. Cdr. Ron Smolowitz. Smolowitz has the distinction of having been the first officer assigned to NMFS in 1971; this is his second tour in Woods Hole. A marine engineer by training, he has overall responsibility for the coordination and completion of several projects related to fisheries gear and hardware.

A rundown of Corps officers assigned to the remaining fisheries research centers and headquarters reveals a similar diversity.

NMFS is free to transfer officer billets to any program area if priorities so dictate. This recently took place in the Southeast Fisheries Center's Marine Turtle Program. To avoid a potential conflict between commercial shrimp fishermen and environmentalists over the incidental catch of several species of marine turtles in the Gulf of Mexico, NMFS implemented an accelerated gear development program to perfect a shrimp trawl that will prevent the bycatch of the turtles. The accelerated program resulted in a need for additional people. To help resolve the problem the Center reprogrammed an existing officer billet from a separate program area to the marine turtle project. Since the officer filling this billet, Lt. Dean Mericus, was soon to be rotated to sea, his rotational relief, Lt. Al Bunn, was transferred directly to the Turtle Program some six months in advance of the normal rotation date.

Another related high priority area is marine mammals, and several officers are working on these problems. Lt. Gary Barone researches and writes permits for public display of marine mammals from his office in the Marine Mammal Division of Fisheries headquarters in Washington, D.C. Lt. Roger Mercer, assigned to the Marine Mammal Division in the Seattle-based Northwest and Alaska Fishery Center, manages the Platforms of Opportunity Project, which compiles data on marine mammal sightings from volunteer observers all along the Northwest Pacific Coast. The Southwest Fisheries Center, based in La Jolla, California, is responsible for conducting most of fisheries marine mammal research. Within the Southwest Center's Marine Mammal Division, Lt. Wayne Perryman and Lt. Terry Jackson are working together as team leaders to plan and coordinate the 1979 Marine Mammal Survey. This will be a combined air and ship survey to measure porpoise populations in the entire eastern tropical Pacific Ocean. The data obtained in this survey will be used by managers and decision makers in NMFS headquarters to limit quotas for the incidental take of marine mammals by both domestic and foreign fishermen.

Jobs such as these sample a broad range of projects, but barely touch the whole scope of fisheries programs. In a dynamic organization such as NMFS, with more than 1800 people working with scores of major programs and literally hundreds of interrelated sub-projects and tasks, the presence of 29 NOAA Corps officers could easily go unnoticed. But, by blending the operational experience of shipboard duty with participation in fisheries research programs, these officers are making a unique contribution to the National Marine Fisheries Service goal to develop and conserve the living marine resources of the United States. □



BIG BIRD

By KURT STEHLING

The great cylinder moves with the grace of all ponderous things in flight, its thin skin gleams in the bright sunlight of the stratosphere. It is like a giant fish of the upper air, something from an older page of aviation history, the era of the dirigible.

Today the sight of a rigid lighter-than-air ship would evoke the flaming demise of the German Hindenburg, or the scattered wreckage of the American Shenandoah, destroyed in a storm. And yet, dirigibles have been an attractive aeronautical alternative since France's Henri Giffard made the first propelled balloon flight in 1852. In the 1920's and 1930's, dirigibles were an attractive platform for scientists engaged in projects that required great range and endurance—polar exploration, for example.

Now there is talk of bringing the airships back, for science.

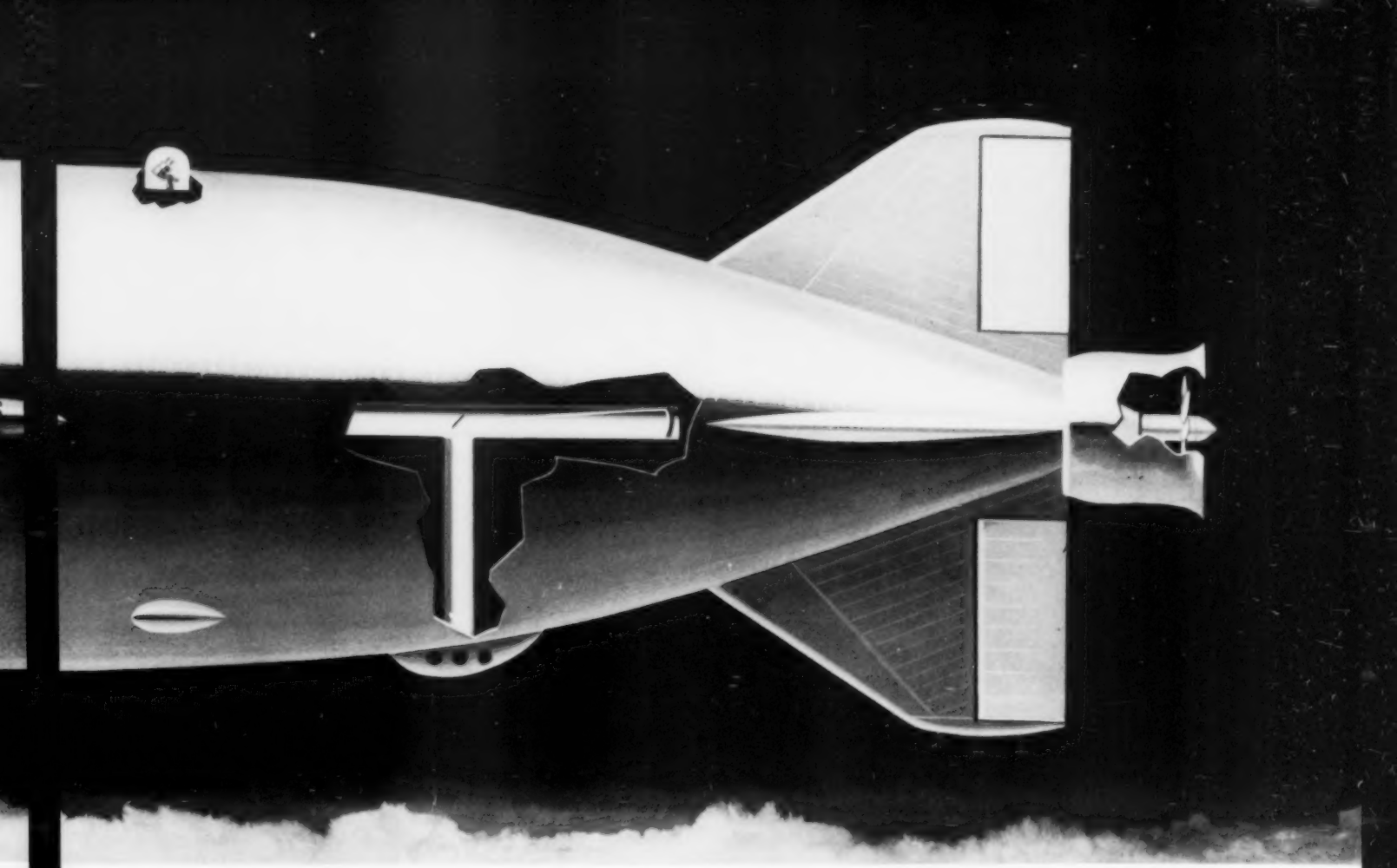
The dirigible we would see today bears only a superficial resemblance to its disaster-prone forebears. While the general shape is similar, the vehicle is larger, constructed of the foams and fabrics and tough, light metals of present-day technology. (The skeletons of early dirigibles looked and weighed like the Eiffel Tower.) Its buoyancy comes from helium in super-pressure bags inside the streamlined outer fuselage, an inert gas instead of the explosive hydrogen. The old radial engines have been replaced by extremely efficient turboprop pods. And the capability is mind-boggling: this modern airship, like one of Captain Nemo's creations, can cruise for weeks at a time at stratospheric altitudes.

The high altitude research dirigible is a dream; but it is a dream that could become an exciting reality—a true ship of the air.

The reason some scientists look longingly toward a modern dirigible is that such a ship would combine the best features of balloons with some of the features now found only in oceanographic research ships, earth-orbiting satellites, and research airplanes of the type now operated by NOAA. With such a platform, they reason, they could hover, or travel great distances, keeping their hands on their experiments (when you release a balloon and its payload, your experiment rides the wind alone).

What criteria would be set down for the ship?

It would have to operate as high as 85,000 feet (28,000 meters), have a cruising radius of about 3,000 miles (5,000 kilometers), and be able to stay aloft for 10 to 20 days. It would carry about 10 crew and 20 scientist-technicians, and provide living and laboratory space for them and their experiments. The ship would also carry some 10 tons of instruments, including solar telescopes and a coronagraph, X- and



gamma-ray detectors, monitors for infrared and ultraviolet radiation, conventional and radio astronomical telescopes, very-high-resolution earth and ocean scanners, and an array of meteorological remote sensors.

An experimental voyage aboard the airship would be like a voyage on NOAA's ship Oceanographer, except that one would sail the thin sea of the stratosphere. As data came in, a shipboard computer would assimilate and process it, providing scentists with real-time looks at the course their research was taking. The routines also would be those of a research ship, although the work would focus on those things best observed from the upper reaches of the atmosphere.

But the ship's scanners would make it an effective platform for taking data from the lower atmosphere and ocean, as well. For example, it might move slowly over the tropical "womb" where hurricanes are born, making detailed measurements of ocean surface temperatures, weather conditions, and other parameters, searching for the unknown mechanisms by which hurricanes are spawned at sea.

The ship would look much like a classical dirgible, but modified in certain important respects for its high altitude mission. It must be remembered that the buoyant gas of the lighter-than-air vehicle expands with altitude in order to adjust to decreasing outside air pressure. A meteorological balloon, for example, rises until its expanding cargo of gas causes it to rupture. The same expansion occurs in a dirigible, but the scale is much greater. Decreased atmospheric pressure at 80,000 feet permits the buoyant gas to increase its volume some 20 times. The research vehicle would have to be able to accommodate this expansion, either with pressurized "balloonets" within its hull, or by internal balloons capable of expanding their volume 20-fold.

Given an appropriate design to contain the expanding gas, we might have a vehicle that took off at sea level with 1 million cubic feet of helium as its buoyant gas, enough to lift a total weight of about 35 tons. What kind of payload would we get from this dirigible?

Having postulated 10 tons of scientific gear, we have only 20 tons left for the crew, hull, empennage, cabins, powerplants, and the like—slim pickings for a 15 million cubic foot vehicle, and an engineering challenge of the first magnitude. Extraordinary elegance and innovation of design would be needed to produce a strong but lightweight hull some 800 feet long and 200 feet in diameter. One possibility is a monocoque egg-shell hull made of very thin—a thirty-second of an inch or less—fiber-reinforced composite material, able to contain helium, a lively gas that is difficult to seal into a container, and still have enough self-rigidity that it would not wrinkle or collapse if interior pressure were lost. The hull would also have to include laboratory cubicles, living quarters, flight deck, communication and data centers, and engine fuel cells.

It is a difficult task for engineers, but one well within the horizon of 1970's technology. If the hull and cabins and observing blisters weighed 25 tons, 10 tons remain for personnel, engines, and fuel and rear propulsion systems. Again, this means almost magical improvements in weight-reduction techniques, with moderate breakthroughs required, especially in engine packaging and weight.

Since aerodynamic drag is very low at high altitudes, propulsion requirements would be low. Given a five-ton weight limit for propulsion, of which four tons were fuel, the vehicle could operate its motors for about eight days.

This blend of an old idea and new technology is still only a concept. But dirigible technology continues to advance in NASA studies, as do the technologies of turboprops and ducted rotors, high altitude aerodynamic design, and lightweight high-strength materials. For scientists interested in seeing their environment whole, from a platform with great endurance and broad capability, it may be time for active discussion of the concept. □

GRITTY CITIES is not a dirty book. It is a book of present-day photographs and history, about 12 middle-sized industrial cities in five northeastern states. It began as an idea in the early 1970's while Bill Matuszeski and his wife, Mary Procter, toured the city of Baltimore. As the city became "rediscovered," the authors began to wonder if there were other old industrial cities just as interesting. After looking at about 40, they chose the 12 described in their book because of their visual consistency, their character, and their history.

"But more than being photogenic or even historic, cities like Hoboken and Reading and Troy are pleasant places to live in," says Matuszeski. "In many cases they have survived the general neglect that American cities have suffered in the last 50 years far better than big cities. Today, old mills are still in use, or have been converted to new uses, and these cities have made an effort to build on their interesting pasts. The tragedy is that so little is known about them."

The title *Gritty Cities* reflects their survival — it means both grimy and spunky. These cities emerge as having that spirit as well as a livability that many people are seeking today.

Bill Matuszeski, Director of State Programs in NOAA's Office of Coastal Zone Management with his wife, Mary Procter. The photographs accompanying this story are from their book, Gritty Cities.

Life's work for CZM's Matuszeski

Renewing Urban America

By VALERIE A. GILLEN

Matuszeski is Director of State Programs in NOAA's Office of Coastal Zone Management. *Gritty Cities — A Second Look* co-authored by Matuszeski and his wife, will be published this fall by Temple University Press. She is a member of the Board of Overseers at Harvard University and a management consultant. They have three children (including year-old twins) and live in Washington, D.C.

Matuszeski's experiences began with his childhood along the Brandywine River and continued with his education in land use, experiences in the Peace Corps with squatter settlements in Venezuela, and a long stint with the Council of Environmental Quality. His personal interest in the use of the land brought him to the Office of Coastal Zone Management as a well-informed environmentalist interested in achieving the best possible use of our nation's coastlines.

When Matuszeski was 12, he lived in the suburbs of Wilmington, Delaware. There, he developed "an abiding distaste" for suburban living he carries with him to this day. He feels that suburbs are inconvenient:

"Before my family moved to the suburbs, I lived first in a row house in the city, then in a small town. Both were better atmospheres for kids," remembers Bill. "When I moved to the suburbs of Wilmington, nothing was within walking distance. Suburban living was constant exposure to deterioration—fields turned into subdivisions, streams becoming polluted, the wildlife run out."

Matuszeski believes that the trouble with suburban living is that it attempts to satisfy the longing to live both in the city and the country.

"What everyone would like to have is a small suburban house with a nonpolluted stream running by it, a shopping center within a 3-minute drive, and probably a baseball game within 15 minutes."

Matuszeski describes what he considers to be the attitude that has developed as a result of the land use patterns developed in this country today.

"Suburban living," he says, "is a series of compromises that many people are finding less and less acceptable. The reason is that people are not really getting any of the inherent advantages of either lifestyle."

The suburban area where he grew up, however, had one advantage—it was adjacent to a well-protected conservation area along the Brandywine River. The owners put the land into conservation trusts which allowed some public access. But these areas were adjacent to what Matuszeski describes as "horrendous strip development and poorly planned subdivisions."

Mary Procter grew up in similar circumstances in the suburbs of Boston. Their mutual distaste for suburban living may have been the beginning of their interest in the cities of this country.

One might ask why someone from Matuszeski's experience wouldn't develop an "exurban" attitude and move out to the country away from development. Matuszeski answers:

"First of all, it is such a hassle to commute. But, more importantly because we don't have preordained land use in our society, you don't have a guarantee that a developer won't buy the land next to your country house and turn it into a subdivision with $150,000 homes crowded together."

Matuszeski thinks that where people choose to live has a lot to do with fashion. He finds it interesting to recognize the land use trends in the country today. For example, he sees that a lot of wealthy people are moving back to the city.

"In Washington, D.C., it is easy to overstate some of these trends because the city is comparatively wealthy and centralized. However, because of the pressure to locate near the center of Government, people are moving closer in. If the big cities in this country would get proper reforms into their school systems, I believe more people would feel comfortable raising their children in the city. Whether or not this change in fashion becomes more broad-based will depend on whether or not the public schools can meet that challenge."

Matuszeski studied urban land use law at

Harvard. He graduated from the University of Wisconsin with a BA in Government before going to Harvard. He wrote his thesis on open space preservation—how to preserve property without buying it outright with public money and at the same time recognizing that one could not preserve open space simply by regulating it since the Constitution allows people reasonable use of the land.

Matuszeski's interest in land use patterns brought him in the sixties to the squatter settlements of Venezuela as a member of the Peace Corps. (Coincidentally, Mary Procter was a member of the foreign service in Brazil at the same time.) As an employee of the city of Valencia, he worked with the organizers of squatter settlements to provide better services such as garbage, sewage, public light, and water systems.

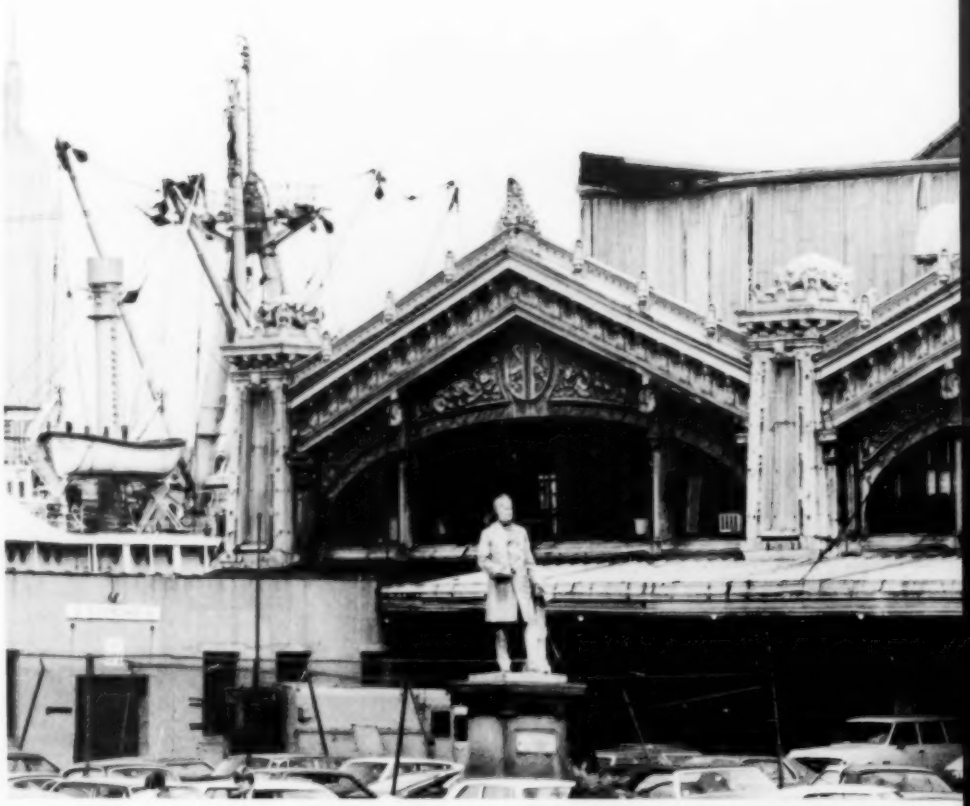
"The traditional approach in handling the squatters was to ignore them," said Matuszeski. "But, the settlements were organized so poorly that at times it was impossible for people to get access to these communities. Because it is nearly impossible to stop the people from settling on municipal land, the only thing to do was to try to accommodate them."

Matuszeski's job was to get involved in the early planning of these settlements and help the squatters properly lay out the streets, set aside areas for schools, and generally get some organization into the community. One big problem was that they tended to settle in undeveloped low areas where the water table was so close to the surface that outhouses wouldn't work.

When he left the Peace Corps, Matuszeski came to Washington, D.C. looking for a job with an environmental agency. But in 1969, no such agency existed. He took a job as special assistant to the Director of the United States Information Agency where his Peace Corps experienced helped in his work with the USIA's young foreign service officers. During his stay with USIA, he traveled to The Hague, where he found "an interesting exposure to the Dutch society," and to Africa where he worked at Voice of America facilities and in information libraries.

A year later, he was asked if he would like to work on the new Council for Environmental Quality (CEQ) then being formed by Under Secretary of Interior Russell Train. The council was in the Executive Office of the President; its mandate was the National Environmental Policy Act (NEPA) which stated that before any Federal agency could do anything related to the environment it must prepare and issue an Environmental Impact Statement (EIS).

In six years with CEQ, Matuszeski handled a number of issues in land and water pollution, power siting, and environmental conditions. He worked with affected agencies on legislation and the EIS system. He was involved in the groundwork of the EIS system, planning the original guidelines; he worked with such agencies as the Department of Commerce, and the NOAA Office of Coastal Zone Management in applying this new system to their programs.



"It was fun," said Matuszeski, "to see something like the EIS start out as nothing more than statutory language and become something both useful and meaningful. The success the Office of Coastal Zone Management has had in getting programs developed and through the process to approval has been tied very much to the EIS and the Management By Objectives (MBO) system.

"Making a good environmental decision is a lot of trouble and it is important to take the time to sit down and write out your rationale. MBOs give structure to the process and permit you to develop schedules and the measure against those schedules."

Matuszeski believes the EIS system helps to point out the weak areas that may require more attention. In that sense, he feels that it is a useful document.

"If we didn't have the EIS and a requirement to consider alternatives," says Matuszeski, "this probably wouldn't be done nearly as well and more of our programs would be successfully attacked and defeated in court. The most telling point in all the litigation brought by oil companies against CZM programs in California, Massachusetts, and Wisconsin, is that there was not one single new point raised that had not been discussed in doing the EIS."

According to Matuszeski, the future of coastal zone management looks bright now. He feels that CZM has conquered many problems along the way, of which one was credibility:

"When I first came to OZCM, nobody really believed we would get coastal programs approved through the Federal government, State bureaucracies, and State political institutions and structures. Although the west coast had already begun to manage its coastline, there was some doubt as to whether the northeastern States, the Great Lakes States and perhaps most of the South Atlantic and the Gulf were going to take this program seriously. I think that for the most part we have overcome that credibility problem.

"Coastal management includes many politically difficult issues. We are trying to come to grips with the tradeoffs between public benefits and private land ownership; and between regulating the uses of waters versus free and open use that may end up creating congestion and pollution. These are concepts that are going to come into play and become more substantive. The challenge of coastal management is shifting away from whether or not programs will get approved towards what the programs will accomplish.

"Coastal Zone Management is a program that accommodates development as well as preservation. It is a program that leaves a lot of discretion to the States, and in some cases local governments, on individual decisions because it has been recognized that the Federal categorical approach on an issue-by-issue basis does not work out well."

The Coastal Zone Management Act (CZMA) of 1972 was a precursor for some of these developments. It did allow for economic development and encouraged proper development in the right places. To that extent, it is similar to the community development block grant program of HUD (Housing and Urban Development) which leaves discretion to the cities and removes some of the unpleasant aspects, such as demolition and clearance for urban renewal to the states. It is clear from the beginning that the States must become involved in these issues and that Federal money is "seed money" to help the States address these issues.

"Coastal Zone Management came around in the environmental movement as a spin-off toward land use legislation in the early 1970s," says Matuszeski. "It was a law that was adaptable to the realities of government later in the decade—realities that are moving toward accountability, simplification, and appreciation for the limit involved. So with that kind of basis, I think it is a sound program going into the eighties."

Given the most optimistic of estimates, CZM expected to have about 14 states approved by October 1. Matuszeski feels that it would not be fair to give up on those States that haven't quite made it by 1980 because of the amount of work already done and the importance of those States.

They will be left with the option of funding on their own after 1980 and asking for approval from OCZM for implementation funds. These important states include Alaska, which has 36 percent of our coastline; Florida, which has 8 thousand miles of shoreland; Louisiana, which has half of the wetlands of the country; and Texas, which has more barrier beaches than any other state.

Coastal Zone Management is a program that Matuszeski feels needs to be questioned in terms of its continuing utility. He believes that there is much more to add to coastal management in the way of substantive activities for States to become engaged in, such as fisheries; more active energy siting, and hazards.

"The Act barely mentions hazards," Matuszeski said, "yet it is a critically important issue in the coastal zone. The CZMA focuses on the natural resource side and on the development side; but, it doesn't really face up to coastal storms, hurricanes, and flood driven tides.

"This is true because it is difficult to legislate against acts of God. There is the belief that to a certain extent you cannot protect all humanity from all things that are going to happen. But, I think there is another element that is perhaps more important—a great reluctance on the part of Government to tell people when they are safe and when they are not. The difficulty in dealing with hazards in coastal management is telling people that they shouldn't expose themselves to danger when they have a clear choice not to."

Matuszeski feels it will raise an interesting set of issues if coastal management moves into an effort to protect human life and property from exposure to hazards. The Flood Insurance Program provides some limited experience to what is an appropriate role for the Federal Government. The real question, he believes, is whether that program will stand up to the postdisaster pressure for Government aid.

"Some people say that CZM isn't going to be much of a program until it faces what is really the gut issue—human life and property," says Matuszeski. "Others will say that what is important is to preserve the resources, which will maximize the capacity of the coastal zone to absorb these storms and if people expose themselves there really isn't much you can do."

Coastal Zone Management still has a massive job to do, and Matuszeski will continue to apply his experiences in land use and coastal management to get the job done. He feels strongly that the job will be done successfully because of the quality of the OCZM staff whom he describes as "a cohesive group of people all working together and one that has enough old timers to give it character and just enough young people to keep it snappy."

Not unlike his Gritty Cities. □

Three-agency teamwork saves lives and ships

Dangerous Passage-The Columbia River Bar

By JOAN VANDIVER FRISCH

NEARLY ONE HUNDRED YEARS AGO, the mouth of the mighty Columbia River between Washington and Oregon was the scene of a maritime tragedy that continues to haunt helmsmen of modern-day fishing vessels and pleasure craft who venture near the treacherous shoals. On May 4, 1880, an entire fleet of small salmon fishing boats suddenly was caught in gale-force winds blowing in from the Pacific Ocean. One by one, the small vessels lost the battle with the pounding seas and never returned to port.

During the past two and a half centuries, more than 100 sea captains who chose to defy nature's warning signals—dense fog, violent winds, and roaring breakers—have earned the dubious distinction of a permanent berth in the "graveyard of the Pacific," upon trying to cross over the Columbia River bar.

From stately three-masted schooners and barks, loaded with Northwest lumber, furs, grain, and cement, to clumsy fishing junks, swept eastward by the strong Japanese current, the wrecks remain an ever-present reminder of the Columbia's cargo of shifting sands.

Since the construction of man-made jetties, the deepening and widening of the river channel by the U.S. Army Corps of Engineers, and the implementation of more modern methods of weather prediction and communication by what is now the National Oceanic and Atmospheric Administration, the toll of lives and ships has diminished dramatically.

However, the treachery of the river's current as it meets the oncoming ocean tide, accompanied by frequent winds from the southwest, continues to be a threat to human life and property that precipitates hundreds of search-and-rescue missions carried out by the United States Coast Guard.

For example, on September 13, 1976, the *Pearl-C*, a charter fishing boat carrying 10 persons capsized and sank on a windy, rainy night while being towed across the Columbia River bar by a Coast Guard motor lifeboat. Two persons were rescued, one person drowned, and seven others, including the vessel's operator, were never found.

As a result of a thorough investigation of that accident by the National Transportation Safety Board, NOAA was asked to "develop an oceanographic measurement system to measure, process and report those sea conditions which are important to the safe navigation of boats crossing the Columbia River bar."

To meet this challenge, scientists with the Pacific Marine Environmental Laboratory in Seattle, Wash., are cooperating with the National Weather Service and other government agencies—including the Coast Guard and the Corps of Engineers—to implant wave rider buoys in the Columbia River bar. The buoys, approximately one meter in diameter, will gather wave height and length data on site and relay the information to shore-based equipment which will tape and reduce the data.

In addition, a time-lapse camera will photograph a conventional radarscope which will be mounted at Cape Disappointment, Wash. The radarscope pictures will provide information on the two-dimensional structure of the wave field timed with the wave rider buoy measurements in the entrance channel. This information will be interpreted by Dr. James Overland of PMEL and Dr. Lee Harris of the Corps' Coastal Engineering Research Center, as part of the Corps' Columbia River entrance channel study.

Instrumentation on the Seasat-A satellite

Even the presence of the Coast Guard's largest life boat station on Cape Disappointment (below), cannot keep vessels such as the foundered tuna boat Betty M (right) out of trouble in the perilous entrance to the Columbia River bar.

To augment this information, the Corps is conducting a motion study of deep-draft ships as they enter and leave the rough waters of the Columbia River bar. Two hundreds pounds of electronic equipment will be placed on Chevron Oil and Weyerhauser Timber Company vessels to record the ship's movements as they negotiate the narrow entrance channel. The equipment will remain on the ships for a year as they ply the waters between Everett, Washington, in Puget Sound, and the Pacific Coast then 100 miles inland to Portland, Ore., on the Columbia River, and on down the coast to Coos Bay, Ore., and San Francisco, Calif.

Since the Columbia River Bar Pilots organization was established in 1847, every foreign vessel and every large American ship whose master is not licensed must employ one of the 18 experienced bar pilots to guide the ship through the shoals and upriver to its destination. In 1977, the pilots made 4,600 passages in and out of the river's entrance.

As a result, no deep draft vessel has been wrecked on the sands since the *Captayannis*, a Greek freighter, grounded on the shoals on October 22, 1967, while trying to negotiate the channel without the services of a Columbia River bar pilot.

But there are hundreds of smaller vessels that depend on marine weather forecasts to determine safe passage through the bar's shallow spits and rough waters. Just one year ago, a tuna fishing boat, the *Betty M.* lost her bearing in the channel in dense fog and foundered—a reported $4 million loss.

According to James Wakefield, the meteorologist-in-charge of the NWS Regional Forecast Office in Portland, the main concern for wave forecasts at any river bar leading into the ocean is at ebb tide. By calculating when the receding tide occurs and applying this information to wave data fed into a computer at Oregon State University, the NOAA meteorologists issue wave forecasts twice daily—at 10:30 a.m. and 10:30 p.m.—via NOAA Weather Wire to press and weather offices in the region. The Coast Guard station at Astoria, Ore., then broadcasts this information via very high frequency radio to all vessels in the area.

Because the sands in the bar shift all the time, the Portland Weather Service Forecast Office also receives on-site wave condition observations from the Coast Guard's motor lifeboat station at Cape Disappointment north of the entrance.

To understand the need for such information, one must visualize the geography of the Columbia River bar, and the amount of boat traffic that crosses the dangerous area.

Where the tides of the Pacific meet the ongoing Columbia, flowing at an average rate of 90,000 to 1,000,000 cubic feet per second, the river has built up sand deposits that stretch for a hundred miles up and down the coast. South of the Columbia River entrance lies Clatsop Spit, a shallow crescent of sand that caused the grounding of many ships before completion of a five-mile long jetty in 1894. North of the en-

Jetties at the Columbia River entrance channel help ships over the hazardous bar and help maintain a 48-foot entrance depth. This is the south jetty as seen from the ocean. Constructed in 1894, it curves in to join the land at Clatsop Spit, Oreg. NOAA wave rider buoys will be placed in the channel to monitor the rough waters (above). Corps of Engineers' hopper dredges maintain the Columbia River entrance channel (top right).

trance stretch the fingers of Peacock Spit, another treacherous shallow area, backed by the towering rocky promontories of Cape Disappointment and North Head.

After the agency that later became NOAA's National Ocean Survey recommended a man-made extension north of the river's entrance, construction of a two-mile jetty westward toward the open Pacific was completed in 1915. The jetty shields vessels entering the Columbia River from the menacing Peacock Spit.

The offshore current is a combination of the tidal current, the outflowing current from the Columbia River, and the wind-driven current, explains Dr. Overland. The wind-driven current on a given day is determined by the magnitude and direction of the wind over the preceding several days.

Because of jetty locations and tidal currents, sea conditions on the bar can change rapidly with time and location. Furthermore, it is difficult from the seaward side to determine conditions on the bar since the front of the waves or breakers cannot be seen. In the daytime, when visibilty is adequate, it is possible to get a report from the watchtower at Cape Disappointment. But at night, there is currently no way, except by venturing on the bar, to determine actual conditions.

As a result, small boats generally rely on direct observation of the sea conditions to gamble on a safe crossing.

In fog or darkness there is no suitable means of determining actual conditions with enough precision to assure that small boats can cross safely. For this reason, the wave rider buoy data gathered by Overland could play an important role in future marine weather forecasts. One of NOAA's aims in improving the marine weather forecasts is to reduce the number of search-and-rescue missions the Coast Guard is called upon to conduct.

In the meantime, the Cape Disappointment Motor Life Boat Station Coast Guard is the largest lifeboat station in the U.S. Coast Guard and the busiest station on the West Coast. The number of small boats plying the waters between Memorial Day and Labor Day is very large.

According to Cdr. Michael Cole of the Coast Guard Air Station at Warrenton, Ore., near Astoria, it is not uncommon to have 400 boats off the mouth of the Columbia River bar within a five-mile radius and 1,500 boats within a 15-mile radius in July or August or on weekends. Between Tillamook Head, Ore., and Grays Harbor, Wash., a distance of 65 coastline miles, there may be as many as 4,000 boats on a summer weekend.

As a result, the Coast Guard station, located southeast of the bar, makes about 250 search-and-rescue missions per year with its three HH-3F "jolly green giant" helicopters and averages more than 600 hours of flight time during the months of June and July.

Last year, the Coast Guard's Cape Disappointment Motor Life Boat station across the bar on the north recorded a total of 823 search-and-rescue missions. Of that number, 680 occurred bewteen June and September. And the station estimates that approximately 2,400 people were assisted, 75 lives were saved, and $15.5 million in property was salvaged. In 1976, the same station assisted 2,963 people, saved 108 lives and salvaged $39.9 million worth of property.

"The Coast Guard provides assistance by law for life and property in jeopardy along the coast of the United States," explains Lt. Gordon Lawrence of the Cape Disappointment station.

"Usually a boat drifts into the vicinity of the hazardous bar with its motor turned off while fishing and is then unable to start the engine," Lawrence explains. "As a result we are called to tow the boats out of danger."

During the summer, most of the search-and-rescue missions are typically for 24-foot pleasure craft. On weekends, the Coast Guard stations' radios are constantly busy and the activity only subsides between 11 p.m. and 4 a.m.

To meet these needs, the Coast Guard has a motor lifeboat in the water at all times between 4 a.m. and late evening for quicker rescue service.

"We have had so many boats broken down on the bar during the summer weekends or on holidays that all seven Coast Guard lifeboats have been in service at once," Lawrence says.

Because of increased marine traffic nationwide and, particularly, a sharp rise in the boating activity among small vessels around the mouth of the Columbia River, NOAA is required to maintain a closer watch on the environment and fulfill a need for more precise weather forecasting and other services," explains Dr. Glenn Flittner of the National Weather Service's Ocean Services Division.

"Our overall objective is to enhance the safety of life and property at sea and in particular around heavy traffic areas such as port and harbor entrances like the Columbia River bar. The project is part of a larger program of NOAA's Ocean Services Division to augment similar programs at other ports and harbors around the country."

The Columbia River bar wave rider buoy project is one step toward making NOAA's overall objective a reality. □

A broadcast interview with David S. Johnson, Director of the National Environmental Satellite Service

NOAA Satellites: Working For You

Today we know more about our total environment than at any time in our history, and much of this knowledge has been and is being collected by NOAA's environmental satellites. Recently, David S. Johnson, Director of NOAA's National Environmental Satellite Service, participated in a NOAA public service radio presentation, "The Sea and the Air," from which the following interview was taken. Mr. Johnson is recognized internationally for his 20 years of work in research, development, and technical management associated with the satellite program.

Q. Mr. Johnson, would you comment on the size and capability of today's satellites compared with those of a few years ago?

A. I think that more important than size is the sophistication of the technology. For example, there has been a revolution in solid state circuits. We see it in our home radio and TV sets. They get smaller and smaller while the quality gets better and better. The same thing has been happening in space; indeed, probably the developments in space technology resulted in these improvements in the technology available at home. We now are able to see the clouds and earth's surface with much higher resolution than when the program started some 18 years ago, and we can look in different portions of the spectrum, such as the infrared, from a distance of more than 23,000 miles away, with a temperature accuracy or resolution in the order of one to two degrees Celsius. It is this kind of thing that has revolutionized the business of observing the earth from space.

Q. Would you elaborate on the types of environmental data NESS collects?

A. We acquire measurements of various forms of electromagnetic radiation which we can convert into physical parameters such as the atmospheric winds, the sea surface temperature, the snow and ice cover on the earth's surface, the location and speed of storms, and even such things as the distribution of air temperature from the surface of the earth out to the stratosphere.

Q. What is done with all this data after it is assembled?

A. The data are processed and converted into forms required by our users and distributed to them by a wide variety of means. They include the National Weather Service, obviously. The National Marine Fisheries Service has been working with our satellite data to improve the productivity of fishing; several operational programs involve us with various fishing companies and associations. We work with the Coast Guard and the Air Force on air-sea rescue, where satellite data play a very important role. There are many Federal agencies as well as state and local agencies and various industrial concerns that use the data.

David S. Johnson

Q. Satellite technology has contributed to many other sciences; as an example identifying upwelling in the ocean to help fishermen, and, in wildlife management using imagery to learn more about nesting and migration of Canada geese. Could you tell us more about these?

A. Yes, you've picked a couple of interesting applications. In the case of upwelling, the sea surface can be monitored in the infrared portion of the radiation spectrum to detect temperature differences, including those caused by the phenomenon called upwelling. It is known that the food that fish feed on — so-called phytoplankton — is concentrated in upwelling zones. The satellite senses differences in sea surface temperature, from which we detect the upwelling. This information is provided to the West Coast tuna and salmon fishing fleets. They sail directly to the location detected by satellite rather than searching in the blind. They catch their fish much more rapidly that way and, therefore, are much more efficient.

You mentioned the Canada geese. Their mating habits, and productivity of the young are very much dependent upon the kind of winter that occurs in Northern Canada where few, if any, people live. That's where our satellites come in. We continually monitor the snow and ice cover in the area where the Canada geese breed. With this information, experts on geese and their habits can predict what the population growth of the geese is going to be. This information is used in controlling the resource by adjustments in hunting limits and other conservation measures.

Q. What about the snow cover in other parts of this country and its effect on conditions such as drought?

A. This is extremely important, particularly in the western part of the United States. We use the satellite to continuously monitor snowpack by measuring the extent of the snow cover. This information, combined with the relatively sparse ground observations that are available to hydrologists, is used to give a much better estimate of the total amount of water stored up in the snowpack. Another role of the satellite is to assist in determining when this snowpack is going to start to melt, which will give some idea of the runoff. This is of use in two ways: in improving water management by controlling reservoir levels; and assisting in warning of flooding when there is rapid melting of snow. We can show you by pictures the recent drought in the western part of the United States and how it developed over a period of several years. Satellite photos show the change from year to year in the snow cover in the western mountains.

Q. What about other uses that the public would not ordinarily associate with satellites?

A. One of the very interesting ones is

dependent upon infrared sensing. We can measure the location and approximate strength of the Gulf Stream, including large eddies or circular pools that develop along its edges. The Gulf Stream moves northeastward with a speed of several miles per hour, and very strongly affects commercial ship traffic. If a boat travels with the Stream and in the region of the strongest current, of course the vessel is going to move faster, get to its destination sooner, and save fuel. Conversely, if a ship is going in the other direction against the Stream and doesn't know it is in the middle of the current it will be slowed down dramatically, and operating costs will be increased significantly. This now is used operationally. We actually provide observations to the Coast Guard that are broadcast to marine interests offshore, whereby they can know where the Stream and eddies are. By taking advantage of this knowledge, large savings in fuel and trip time can be obtained.

Another example is the use of the geostationary satellite's infrared data to keep track of the frost line as it moves during winter nights in Florida. This information is used by the National Weather Service in providing improved warnings to the citrus farmers. They talk of saving tens of thousands of dollars per hour in frost prevention costs if, by providing improved information to them on a 30-minute interval, they can wait until absolutely necessary to implement prevention measures.

Q. I am sure the satellite serves a very useful purpose in ice monitoring in the Arctic and the Great Lakes?

A. Yes, it does, in both areas. We use the satellite to detect the presence of ice and its distribution. From the brightness of the images, we also can say something about the thickness of the ice. This is used in large areas of the world, particularly on the routes to Prudhoe Bay in Alaska in support of oil field development there, in the Antarctic for the resupply of our bases down there, and, as you mentioned, in the Great Lakes.

Q. Would you pinpoint some of the other benefits to mankind that can be attributed to satellites?

A. We should not lose sight of the earliest reasons for the NOAA satellites, and that's in weather warnings and forecasts. We find they play an extremely important role in tracking hurricanes and tropical storms. We are able to estimate quite reliably the strength of these storms, which is very important in making forecasts of where they are going to go and how severe the damage might be. The geostationary satellites now provide essentially continuous monitoring. Another severe weather condition that is under continuous monitoring is tornado-breeding storms, or thunderstorms that often can cause extreme damage and loss of life. I think you will find that the record of performance of the National Weather Service has improved since the advent of the geostationary satellites, which are very important to this service.

Q. Speaking of hurricanes, do the environmental satellites give you an earlier point of information?

A. Yes, that is correct. Before satellites, we had to rely upon the occasional ship or aircraft report to indicate that there was even a storm around. Now, satellites detect the storms in their earliest, incipient state. They are under constant surveillance until they die and disappear. So they are never out of sight of at least one of our satellites. In the case of tornadoes, the satellite can give earlier warning of the development of the kind of thunderstorm that is most likely to cause damaging winds or a tornado, as well as more explicit information on such a storm's location and movement. There is considerable research going on using satellite, radar and other ground-based data to see if we can better understand what triggers a tornado. We are hopeful that these new observing techniques and theories now being developed will indeed lead to a breakthrough that would allow NOAA to increase the warning time for the tornado itself.

Q. What lies in the future in satellites — what about looking ahead two or three decades for us?

A. I think we are going to find satellites being used much more extensively in other fields of the environment. Microwave sensors will allow us, perhaps, to measure the waves on the oceans around the world — their height and distribution, to be able to measure tides very accurately, to significantly increase our knowledge of the oceans. We expect to be able to monitor important atmospheric components, such as ozone, that are of great concern to the health of the population and the effect of man in his environment. I expect it will be possible to get very precise measurements related to climate and climate change, which may help answer some of the questions we have today about what is going to happen to the climate in the future, what man is doing to change his own climate, and what kind of government action should be taken to avoid a disaster later on. I can visualize that it won't be too long — maybe in five to ten years — before each of us will be able to carry on our wrist a radio receiver to get weather warnings all of the time. When we go home, or to our office, we will be able to punch a button on the TV set and see the latest satellite pictures with the clouds and the storms in motion. Superimposed on them probably will be a map of the radar echoes showing the areas where there is rainfall. We will be able to say, "I guess I better get out to the parking lot and get into my car before that little storm hits me." This is all feasible today. It is just a matter of money. But, with the revolution we have seen in the last 25 years, and no abatement in the development of lower and lower costs of solid state devices, I think that even money will not be a limitation in a matter of a very few years. □

THE VIEW FROM SPACE

As NOAA magazine was going to press, NOAA's newest satellite was GOES-3, a geostationary spacecraft positioned at 135 degrees west longitude, above the Equator over the Pacific Ocean. GOES-3 was launched on June 16 by NASA from Cape Kennedy, just in time to begin hurricane warning duty for the eastern Pacific. It was GOES-3 that tracked Hurricane Fico's threatening approach to the Hawaiian Islands during July. GOES-3's reign as NOAA's newest, as of this writing, is expected to be short-lived. On September 15, NASA is scheduled to launch the first in a new series of polar-orbiting spacecraft, TIROS-N. Although paid for by NASA, TIROS-N will be operated by NOAA, and a twin to that satellite, to be known as NOAA-6 and funded by NOAA, is scheduled for launch before the end of 1978.

1 and **2** Thirteen days after launch GOES-3 began returning imagery to earth. Its maiden views of the planet are reproduced here. Picture 1 is the first imagery in two-mile resolution recorded by the visible radiometer onboard, while Picture 2 was acquired at the same time, but with the infrared radiometer. In both images, Hurricane Daniel is prominent, south of Baja California. The spacecraft was en route to its permanent station at 135 degrees west longitude on this date—June 29.

3 By July 17, GOES-3 was a month old and was on station, watching Hurricane Fico as it moved westward toward Hawaii. An unnamed tropical storm is off the coast of Mexico. Comparison of this full disk visual image with Picture 2 illustrates the different view of the globe from GOES-3's permanent station.

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NOAA Shares An International Experience

People And The Coast

By DALLAS MINER*

Dallas Miner of CZM was an interested participant at the international coastal zone conference. (Photo: Shelly Gilroy)

"THE COASTAL AREA of our nation is a rich and varied resource. It is vital to our economy, an important place for recreation, and a barrier to the forces of the sea."

So began the opening speaker at a conference on coastal resource management. Scores of such meetings have started in much the same way—with a declaration of the uniqueness and value of shoreline resources and the effort needed to resolve growing conflicts in coastal management.

The audience was a familiar mixture of citizens, environmentalists, industrial managers, and government representatives. The conference was "People and the Coast," and the place was Delft, the Netherlands. It was the beginning of an international exchange on problem-solving in coastal resource management.

Brought together by the California-based "Institute for the Human Environment," representatives from five nations gathered first at the University of Delft, later at the Universita di Venezia, and finally in Rome.

As is so often the case, the conferees discovered early that the similarities among nations far outweighed the differences.

The Dutch, however, have a special relationship with their coastline. Beginning in the 12th Century, the people of this coastal lowland have worked to establish a secure foothold at the water's edge. The folklore image of the boy with his finger in the dike has become a symbol of the dedication with which the Dutch have faced their "centuries-long struggle with the sea."

Although remnants of medieval efforts still can be seen along the shore, the Dutch began their assualt on the sea in earnest in 1918 with the Zuider Zee Act. The brainchild of Cornelis Lely, the Zuider Zee project has three objectives: greater safety from flooding; better water economy, including creation of a fresh-water basin; and expansion of land for agriculture. The first two objectives were met by construction of the Barrier Dam, completed in 1932, which cut the Zuider Zee (now called the IJssel Meer) off from the sea.

The creation of agricultural and living space is an ongoing process of diking and filling, thus forming thousands of acres of new land areas called "polders." The emphasis has been and is on, as one Dutch engineer put it, "assisting nature to reclaim the land." As with changes in the United States, this attitude is tempered with new concerns for environmental protection, open space and wildlife preservation.

Preservation of natural wetlands is an issue linked both to commercial and sport fisheries and to wildlife habitat. Establishing areas for recreation and open space is finding its way into the planning process. And a new emphasis on public participation is making inroads into what some Dutch citizens claim to be a rather closed-door planning process. As in the U.S., change is a dynamic process involving a variety of factions and special interests.

The debate within coastal planning in the Netherlands, however, is not whether to continue the Lely plan, but how. The engineering genius of the Dutch is being used not only for dikes, dams, and fill but for a myriad of social and environmental objectives.

"People and the Coast" provided an excellent opportunity for the Dutch and American delegates to exchange experience and views in dealing with these new concerns. Of particular interest to the Dutch was the United States experience in using the environmental impact statement as a major tool in decision-making, and also the process of public participation.

The management of ports—in particular, the roles of various units of government—was another issue of interest to all delegates. The Port of Rotterdam, long one of Europe's trade centers, is managed both by the city of Rotterdam and the Dutch govern-

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Dallas Miner is Chief, External Relations Staff, Office of Coastal Zone Management

Venice—a unique coastal city visited by the conference participants (above). The dike under construction (below) across the mouth of the Zuider Zee was protected by thick willow matting sunk in place by weights. (Photo: Dienst der Zuiderzeewerken.)

Changing the salt-water Zuider Zee into the protected fresh water IJssel Meer (clockwise from left): blocks of concrete used to cover the embankment that closed off the bay; the completed barrier dam, with ocean on one side and enclosed sea on the other; sealing the 30 km. long barrier dam; new land (polders) built in the enclosed sea. (Photos: Consulate General of the Netherlands.)

ment. As such, there are both local concerns for water quality, recreational access and jobs, and national interests in the port's economic viability.

New plans for Rotterdam's estuary reflect these varied concerns, and accommodations are being made that will balance economic development with other public interest needs. At the same time, development continues on EuroPort, which represents the Dutch commitment to a maritime trade economy. A tremendous public investment is being made, in terms of land and money, to make EuroPort the largest port facility on the Continent.

While this development continues, concerns over oil spills, tanker safety, air and water quality, and land use management are becoming quite visible in the planning and marketing of EuroPort. At the time of the conference (April 17-20, 1978), the Amoco Cadiz was still aground oozing her cargo onto the north shore of Brittany (see NOAA, Vol. 8, Number 3) and the reality of oil risk was very much on the minds of European coastal and port planners. Still, there is a sense of necessity and optimism for EuroPort development. Necessity, because the Dutch feel that to remain in the forefront of the competitive business of international trade, EuroPort is a must; optimism, because the Dutch have faced centuries of challenge as neighbors of the sea and feel that they have developed the talents to be winners.

At another port, hundreds of miles away, similar challenges are at issue. The Port of Venice and the Venice Lagoon (the second stop for "People and the Coast") are a classic study of estuarine use. Here is a mixture of history and tourism, modern economic development, traditional water-based industry, and growing demands for recreational access. Venice Lagoon has long been an attraction as a major seaport. The City of Venice, with its colorful canals and gondolas, relies on the tidal flow to flush away the many bi-products of an urban center. Nearby, a busy port entertains cargo and cruise vessels which bring goods and visitors to northern Italy. At the mouth of the Lagoon, commercial and sport fishermen gather the sea life that is so much a part of the local diet.

Spotted between port facilities and new development are patches of open space dotted liberally with tents, recreational vehicles and people on holiday—the attraction to the shore is truly universal. In fact, Italian planners point to this interface—industrial development and tourism/recreation—as the most challenging conflict in coastal management.

Although the beaches of southern Italy are more noted as a recreational amenity, conflicts with this shoreline use are apparent everywhere. Resolving these issues is complicated by the changing nature of governmental jurisdiction in Italy. Until recently, nearly all major decisions were made by the central government with some issues being the prerogative of local government.

Now, a regional system of planning has brought a new perspective to coastal management. As in Holland, the Italian planners were interested in the Environmental Impact Statement process and, in addition, probed the U.S. CZM experience in combining na-

Closing off the Zuider Zee, the coastal zone conferees learned, decreased the Dutch coastline by 300 km. These views show some of the areas where land and freshwater lakes replaced the salt sea. (Photos: Consulate General of the Netherlands.)

tional interests with local or regional interests. An important element in the U.S. Coastal Zone Management program is "adequate consideration of the national interest" in decisions made by state government.

In addition to intra-regional concerns is the substantial interest in international cooperation. The U.S., being a federation of States, has certain advantages over a continent of neighboring nations, although a number of European planners pointed to the United States/Canadian agreements on management of the Great Lakes as a model for international accord. The widely discussed Mediterranean "Blue Plan" is one of several efforts to develop comprehensive plans for management of shared resources.

The value of international dialogue can be measured by many yardsticks. Among them are the personal associations and contacts made that ease the path for continued exchange. "People and the Coast" opened many of these doors for European and American coastal planners. Within the next year, several conference delegates are planning to visit the U.S. and will be coming to a number of NOAA units for information exchange. Their interests cover the range of NOAA expertise and their experiences will be useful for our many programs. □

Sea Fare

Cooling autumn weather brings a quickening of the social pace and a sharpening of appetites—two good reasons for a delicious seafood spread featuring

FUN FOOD FOR FALL

Try these combinations of fine food and company. Charitable, social, and political committees will vote "aye" for **Crabmeat Broccoli Casserole** *or* **Salmon Pearadise,** *a Pacific Northwest specialty. An out-of-the-ordinary special brunch is* **Sea Scallops—In Shells** *or the* **Sunny Crab Sandwich. Catfish, Spanish Style,** *might precede the camera club meeting with a member's snaps of Spain, Majorca, or Mexico. The epicurean tastes of the gourmet club would be well served by* **Poached Haddock with Mussels,** *double delicacies. After the hard work of fund raising, the group would be cheered by a seafood dinner of* **Sherried Tuna.** *These ideas for combinations are from the NMFS's National Fishery Education Center. Try some of your own. It's fun—and good eating.*

Crabmeat Broccoli Casserole

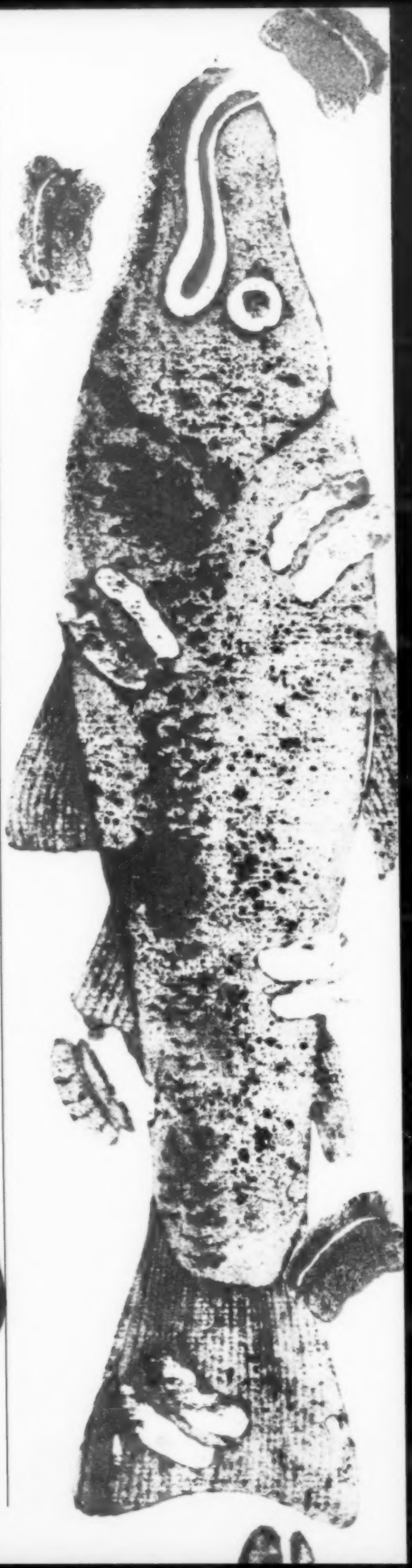
- 1 package (6-ounce) frozen king, snow, or other crabmeat or
- 1 can (6½ or 7½-ounce) crabmeat
- 1 package (10-ounce) frozen broccoli spears
- 2 tablespoons margarine or butter
- 2 tablespoons flour
- ½ teaspoon salt
- 1 cup half-and-half or milk
- ¼ cup thinly sliced green onion
- 1 tablespoon coarsely chopped pimiento
- 2 tablespoons slivered almonds

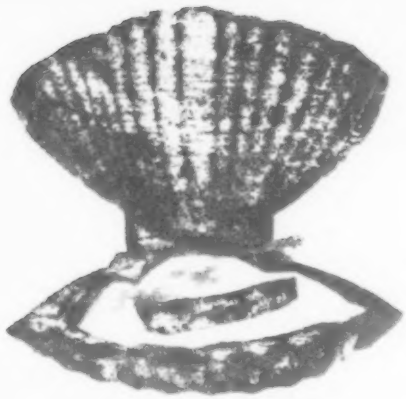
Thaw crabmeat if frozen; drain well. Remove any remaining shell or cartilage. Thaw broccoli and cut stems into bite-size pieces, keeping flowerettes separate. Melt margarine or butter in small pan; stir in flour and salt. Stir in half-and-half or milk; cook over moderate heat until thickened, stirring constantly. Fold in crabmeat, onion, and pimiento. Arrange broccoli flowerettes around edge of a shallow baking dish or heatproof platter, 10 by 6 by 2 inches. Fill center with remaining broccoli pieces and spoon sauce over broccoli in center of casserole. Sprinkle nuts over top. Bake in moderate oven, 375° F., 20 minutes or until hot and bubbly. Makes 4 servings.

Salmon Pearadise

- 1 can (29-ounce) Bartlett pear halves
- 1 can (16-ounce) salmon
- 2 cups cooked rice
- ⅓ cup slivered green pepper
- ⅓ cup coarsely chopped walnuts or toasted slivered almonds
- ¼ cup chopped chutney
- ⅓ to ½ cup tart French dressing
- Parsley or salad greens for garnish

Chill pear halves. Drain salmon and flake coarsely. Combine salmon with rice, green pepper, walnuts or almonds, and chutney. Toss with French dressing to coat lightly. Drain pears. Line salad bowl with pears, placing pointed ends of pear halves up. Mound salmon-rice mixture in center of pear-lined bowl. Garnish with parsley or salad greens. Makes 6 servings.





Sea Scallops — In Shells

1½ pounds sea or other scallops, fresh or frozen
1 cup water or ½ cup dry white wine and ½ cup water
1 teaspoon salt
¼ cup margarine or butter
½ pound small mushrooms, sliced
⅓ cup finely chopped celery
⅓ cup sliced green onion
3 tablespoons flour
Dash of white pepper
1¼ cups half-and-half
1 tablespoon lemon juice
Dash liquid hot pepper sauce, optional
2 tablespoons chopped pimiento, optional
1 cup very fine soft bread crumbs

Thaw scallops if frozen. Rinse with cold water to remove any shell particles. Cook scallops in water or wine and water and ½ teaspoon salt until tender, about 5 minutes. Drain; save cooking liquid. Cook liquid until it is reduced to ¾ cup. Cut large scallops in half. Melt 3 tablespoons margarine or butter in saucepan. Add mushrooms; cook until tender and moisture evaporates. Add celery and onion; cook 2 to 3 minutes. Stir in flour, remaining ½ teaspoon salt and pepper. Add half-and-half and cooking liquid; cook until thickened, stirring constantly. Stir in lemon juice and liquid hot pepper sauce, if used. Add scallops and pimiento; heat. Spoon into 6 or 8 shells or individual baking dishes. Melt remaining 1 tablespoon margarine or butter; mix with bread crumbs. Sprinkle around edges of each dish. Bake in hot oven, 400° F., 10 to 20 minutes. Makes 6 to 8 servings.

Sunny Crab Sandwich

2 packages (6-ounce, each) frozen crabmeat
1 cup sliced almonds
½ cup chopped celery
½ cup mayonnaise or salad dressing
2 tablespoons lemon juice
6 toasted buttered English muffins
12 cooked asparagus spears (or more, as desired)
6 slices (1-ounce, each) Cheddar Cheese
Paprika
Tomato wedges

Thaw frozen crabmeat; drain. Remove any remaining shell or cartilage. Combine almonds, celery, mayonnaise or salad dressing, lemon juice, and crabmeat. Arrange muffin halves on a cookie sheet, 15 by 12 inches. Place one or more asparagus spears on each muffin half. Cover asparagus and muffin with crab mixture. Cut each cheese slice diagonally into quarters. Place triangles on each sandwich. Sprinkle with paprika. Bake at 400° F., for 15 to 20 minutes or until heated through and cheese is melted. Serve with tomato wedges. Makes 6 servings.

Catfish, Spanish Style

2 pounds catfish fillets, or other fillets, fresh or frozen
2 small tomatoes, peeled and sliced
2 small onions, thinly sliced
1 medium green pepper, cut in half lengthwise and sliced
1 medium lemon, thinly sliced
1½ teaspoons salt
⅛ teaspoon cayenne
2 tablespoons olive oil
6 to 8 stuffed olives, sliced

Thaw fish if frozen. Arrange fillets in a 2-quart shallow baking dish alternating fish with sliced tomato, onion, green pepper, and lemon. Sprinkle with salt and cayenne. Drizzle with olive oil. Cover with aluminum foil, crimping it tightly to edges of dish. Bake in hot oven, 400° F., 30 minutes. Uncover. Baste catfish and vegetables with cooking liquid. Return to oven and continue baking, repeating basting procedure several times. Bake about 10 minutes or until fish flakes easily when tested with a fork. If desired, remove excess liquid with a spoon or baster before serving. Garnish with olive slices. Makes 6 servings.

Poached Haddock With Mussels

2 pounds haddock, cod or other thick fillets, fresh or frozen
4 pounds mussels in shells (about 4 dozen)
1 cup dry white wine
1 cup water
1 small onion, sliced
½ teaspoon salt
½ cup whipping cream
¼ cup margarine or butter
Dash white pepper
Dash nutmeg
2 tablespoons chopped parsley
Parslied potatoes
1 cup each of zucchini, carrots and celery, cut julienne style
Margarine or butter for cooking vegetables

Thaw fillets if frozen. Cut into serving-size portions. Clean mussels in cold water. Scrub shells with a stiff brush, rinsing thoroughly several times. Combine with water, and onion in large pan; bring to simmering stage. Add cleaned mussels. Cover and steam about 5 minutes or until shells open. Remove mussels from shells; set aside. Strain cooking liquid into a large skillet. Add fillets and salt. Cover and simmer 8 to 10 minutes or until fish flakes easily when tested with a fork. Transfer fillets to warm platter; keep warm. Reduce cooking liquid to ½ cup. Stir in whipping cream, ¼ cup margarine or butter, pepper and nutmeg; simmer until sauce thickens slightly. Add mussels and parsley; heat. Spoon mixture over fillets. Serve with parslied potatoes and julienne strips of zucchini, carrot, and celery sauteed in margarine or butter, stirring constantly just unil tender. Makes 6 servings.

Sherried Tuna

2 cans (6½ or 7-ounce, each) tuna in oil
1 cup thawed frozen peas
¼ cup chopped onion
¼ cup margarine or cooking oil
¼ cup flour, ½ teaspoon salt
1½ cups milk
1 can (4-ounce) sliced mushrooms, undrained
⅓ cup dry sherry
2 tablespoons chopped pimiento
¼ to ⅓ cup toasted slivered almonds
Heated patty shells, toasted noodle baskets, or toasted English muffin halves.

Drain and flake tuna; set aside. Cook peas and onion in margarine or cooking oil over moderate heat until tender, but not brown. Stir in flour, salt, and paprika, milk, mushrooms; cook, until sauce is thickened. Fold in tuna, sherry, and pimiento; heat. Sprinkle almonds. Makes 4 to 6 servings.

noaa/update

Weather Modification Advisory Board Presents Report

Weather Control Effort Advised

A panel of weather modification experts say that technologies for increasing rain and snowfall and for lessening weather damage are "scientifically possible and within sight."

They predict that scientists will be able to produce 10 to 30 percent increases in mountain snowpack by the early 1980's, and 10 to 30 percent increased rainfall in the High Plains and Midwest by the late 1980's. By the 1990's, they believe, scientists will be able to bring about 10 to 20 percent reduction in hurricane winds and up to 50 percent reduction in the amount of hail in some hailstorms.

"There is an excellent chance in this field to do things right," says the Weather Modification Advisory Board in its report presented July 12 to Secretary of Commerce Juanita M. Kreps. But the Nation now needs a cohesive, 20-year Federal program, reinforced by State and private agencies, to realize the potential benefits of weather resources management.

To carry out the program, the Board recommends the consolidation of all Federal weather modification activities in a National Weather Resources Management Board, to be associated with NOAA, and with sufficient autonomy to carry out a serious, long-term research and development program in what the Board calls "weather resources management." Basic research support at academic institutions would continue to be provided by the National Science Foundation.

The Board recommends against a comprehensive Federal regulatory system for weather resources management at this time, but asserts a clear need to make sure that both research and operational projects are designed and operated on the basis of sound standards.

Pointing out that progress in influencing the weather for human good is dependent upon how hard men and women work "at developing a body of knowledge that is still only a generation old," the Board report states:

"The case for hastening progress along these lines is very strong. The economic benefits of delivering more water in the right places—for dry farming, for irrigated crops, for hydroelectric power, and for municipal and industrial water use—seem very likely to outweigh the costs by impressive amounts. Large benefits, especially to aviation, can come from dissipating fog on command. Population growth and migration are multiplying the people at risk from hurricanes and other severe storms. If the damage from the weather's occasional fury can be mitigated, the people at risk will insist that the effort be made.

"The public interest requires that deliberate changes in the atmosphere be designed and carried out with environmental prudence and after consultation with the people likely to be most affected. The air and clouds are a public good, belonging to no one. The size and power of atmospheric systems are such that sensible policy must start with Federal responsibility for weather resources management — and a network of international arrangements as well."

Recommending a prudent go-ahead signal—a "green light with amber"—the Board points out that new technologies too often run ahead of social and environmental controls.

The Advisory Board consisting of 17 members from private, public, and academic sectors, was established in 1977 to provide independent and broadbased advice to the Secretary, who—under the National Weather Modification Policy Act of 1976—is responsible for formulating a first-ever national policy on weather modification.

Secretary of Commerce Juanita Kreps receives report from Weather Modification Advisory Board Chairman Harlan Cleveland (center) and NOAA Administrator Richard A. Frank.

NOS Publishes Study of Spring Tidal Flooding

A definitive study of the origin, nature, and impact of severe tidal flooding of lowland coastal regions caused by a combination of astronomical and meteorological forces has been published by the National Ocean Survey.

"The Strategic Role of Perigean Spring Tides in Nautical History and North American Coastal Flooding, 1635-1976," was written by Fergus J. Wood, a former research associate of NOAA's National Ocean Survey. The 538-page volume documents more than a hundred major coastal flooding events of the past, and discusses the related hazards to maritime commerce, seashore habitations, and the coastal environment.

The historical, practical, and environmental aspects of perigean spring tides are summarized in a less technical discussion for the non-scientist, and for the historian, Wood has documented events of the past that were influenced by perigean spring tides.

Sea Provides Possible Cure For Diseases

Twelve chemical compounds recently discovered in such sea creatures as sponges, sea cucumbers, and sea hares potentially are valuable in treating cancer, central nervous system disorders, and cardiovascular problems, researchers supported by NOAA believe.

The scientists, from the University of Oklahoma, have isolated and identified the compounds during the past 15 months, and now are beginning further study on their application to disease. The research is supported by a $116,500 Sea Grant from NOAA, and $58,258 in supplemental funds from the University.

One of the most promising substances, found in the sea hare—a member of the shellfish family—and known as dactylene, already has been tested on rats and mice, and increases the length of time the laboratory animals sleep after being given a barbiturate. Further research could lead to smaller, safer doses of barbiturates—which are addictive—if the substance is found to inhibit their breakdown in humans, as is suspected.

Others of the newly-identified compounds suppress cellular growth in tissue and are candidates for possible anticancer treatment, according to the research team. The scientists are now conducting experiments on laboratory animals to validate the effects of the substances.

Chemicals taken from a number of Caribbean invertebrates and algae have, in the laboratory, inhibited the growth of experimental tumors in mice, and also mitigated cardiovascular and central nervous system disorder induced in small mammals. Isolation and identification of these substances will continue under the NOAA grant.

The newly discovered compounds may serve as models for the synthesis of new drugs. Additionally, the chemical information gained from the research will increase knowledge of the chemistry of marine animals and plants, and define the types of compounds released into seawater from natural sources.

Great Lakes Get Coastal Data Center

A regional coastal information center for planners, managers, scientists, and the public will be established in Ann Arbor, Mich., at the offices of the Great Lakes Basin Commission and the Michigan Sea Grant Program.

Funds for the center, in the form of a $50,000 grant, come jointly from the Office of Sea Grant, Office of Coastal Zone Management, and Environmental Data Service. An additional $25,600 has been pledged by the University of Michigan.

The Michigan center is in addition to similar centers in the Pacific Northwest and Northeast.

The centers allow State and local agency personnel, coastal planners, legislators, and environmentalists, and the general public to obtain information and guidance on coastal area subjects, including laws and zoning regulations, scientific data, and sources of publications.

Endangered Species

Turtles Will Be Protected

A comprehensive program under the Endangered Species Act to prevent the extinction of the oceans' largest turtles — some weighing over a thousand pounds —has been initiated by NOAA and the Department of the Interior's Fish and Wildlife Service.

The program will protect green, olive (Pacific) ridley, and loggerhead turtles by largely banning the intentional killing of these animals, prohibiting trade in turtle meat and products, and preserving habitat.

In recent years, dangerous declines in the numbers of sea turtles have resulted from destruction of habitats and commercial exploitation of the animals. Condominium and apartment construction, opening up of new beaches for recreation, and other human activities have destroyed or put pressures on the traditional turtle nesting areas. Turtle meat is often considered a delicacy, as are turtle eggs, and products made from shell and hides have been in great demand. In addition turtles are taken incidentally in U.S. commercial fishing operations, particularly the Gulf and South Atlantic shrimp industry.

NOAA has jurisdiction over sea turtles from the edge of the water seaward and the Department of the Interior has jurisdiction on land.

The effect of the protective action is to prohibit trade in and the intentional taking of the three species of sea turtles, except for scientific research, public display, and the limited subsistence take in the Trust Territory. While some incidental taking of the sea turtles may continue in fishing operations, such operations are to be strictly regulated to preserve the species. Commercial interests that will be affected by the regulation include leather goods, food, cosmetics, curio and jewelry concerns. A one-year grace period will be allowed for interstate commerce to enable dealers, shopkeepers and others to clear their shelves.

Satellites Undergo Maneuvers

NOAA's GOES-1 satellite is undergoing a carefully controlled series of space maneuvers which will end this winter with the start of an international study of global weather.

The successful launch by NASA from Kennedy Space Center of NOAA's GOES-C geostationary satellite is a key element in the Global Weather Experiment, a worldwide, year-long accumulation of meteorological and oceanographic data which begins in December.

The largest international scientific experiment in history, with 140 nations participating, the Global Weather Experiment depends upon information collected from many sources. Oceanographic and wind observations all over the world will be made by nine satellites and scores of ships and aircraft, while thousands of surface and upper air observations will be made daily by several hundred buoys distributed in the Southern Hemisphere and by conventional observation methods elsewhere on Earth.

The Experiment is a part of the Global Atmospheric Research Program, sponsored by the World Meteorological Organization of the United Nations and the International Council of Scientific Unions. It will be conducted throughout 1979, providing scientists with millions of pieces of information from all over the world.

GOES-1 was replaced in mid-June by GOES-3 satellite to observe much of the Pacific Ocean and the western half of the United States. That spacecraft— GOES-1 —is being moved by stages from its position above the Equator at 135 degrees west longitude almost halfway around the earth to about 60 degrees east longitude.

GOES-1 first was shifted to 15 degrees west, over the Atlantic Ocean, where it is under the control of the National Environmental Satellite Service Command and Data Acquisition Station in Wallops, Va. Space technologists at a new acquisition station being installed in Spain by the European Space Agency are participating in control of the spacecraft for familiarization purposes.

About the first of November, GOES-1 will be in a position over the Indian Ocean, fully under control of the Spanish station and ready to begin providing information on December 1 for the Global Weather Experiment.

In that experiment five geostationary satellites—and four polar orbiting spacecraft—will be collecting data: GOES-1, and GOES-2 above the Equator over South America, and GOES 3; a European satellite in position above the Equator over Western Africa; and, a Japanese spacecraft over New Guinea.

Two of the polar-orbiting spacecraft will be operated by the U.S.: TIROS-N, a NASA satellite, and NOAA-6. The other polar-orbiters will be operated by the U.S.S.R.

The satellite is almost identical to four earlier geostationary environmental monitoring satellites launched by the United States since 1974. Like its predecessors, it provides a variety of imagery of North and South America and much of the Atlantic and Pacific Oceans every half hour. The imagery is used by meteorologists in weather forecasting, wind and cloud cover analysis, severe storm warning and hurricane tracking, and other activities. Oceanographers use information from the spacecraft for ocean current analysis, ship routing, and other purposes while hydrologists find the information valuable for snow melt and snow area determination, water resource management, and various agricultural applications.

In addition, the GOES series spacecraft collect and transmit information recorded by data collection platforms at remote places on land, on buoys in the ocean, and carried aloft by balloons and aircraft. This information is communicated by the GOES satellites to users on earth.

The spacecraft also measure solar activity, detect solar flares, and determine the intensity of solar winds and the strength and direction of the Earth's magnetic field.

GOES-3 is expected to be the last NOAA geostationary satellite to be launched by NASA atop a rocket. Three more geostationary spacecraft are planned during the next eight years, to be carried into space on NASA's Space Shuttle, beginning with GOES-D, now anticipated to be placed in orbit in late 1980.

First Report On Oil Spill Is Released

Oil spilled by the wrecked supertanker Amoco Cadiz last March permeated the marine habitats of the Brittany shoreline to an unprecedented degree, a scientific report released indicates. The oil's impact varied greatly with time after the spill, and was strongly influenced by the shape and nature of the shoreline involved, according to the report.

These were among preliminary findings of government and university scientists in their analysis of the largest oil spill in maritime history. The report, "The Amoco Cadiz Oil Spill—A Preliminary Scientific Report," was prepared by NOAA, in cooperation with the Environmental Protection Agency. A complete analysis of the incident could take several years.

"We had never seen biological damage of this geographic extent in any previous oil spill," Dr. Wilmot N. Hess, director of NOAA's Environmental Research Laboratories, said. He led NOAA's scientific study for several weeks in France, and is editor of the NOAA/EPA report.

According to Hess, the French used more than a thousand tons of dispersants, released from ships outside the 150-foot (50-meter) depth contour, to try to prevent oil from coming ashore. Some quantities of dispersants and detergents were also applied to oiled beaches. "The impact to this heavy use of dispersants," he said, "is not known at this time."

By making the spill the subject of a major study, important new insights were gained into how oil moves and changes in the marine environment.

An important lesson, Hess said, is that the impact of an oil spill varies greatly over different periods of time. "When the oil first hits the beach the contamination is just beginning. The impacts you see depends largely on being at the right place at the right time. For example, it was more than two weeks after the wreck that we saw millions of dead molluscs, urchins, razor and surf clams, cockles, and other intertidal animals killed by oil, or perhaps by dispersants, that had permeated one beach's ground water."

Jackson Heads Office For Civil Rights

Arva J. M. Jackson, formerly a regional manager for HEW in Philadelphia, was appointed Director of the newly created Office for Civil Rights for NOAA.

Arva J. M. Jackson

She administers NOAA's Equal Employment Opportunity Program, the Affirmative Action Program, and the Special Emphasis Programs which include the handicapped, Hispanic, and women. Previously sections of the Personnel Division of the Office of Administration, these programs now function under the Office of the Administrator as the Office for Civil Rights.

In announcing Jackson's appointment and the creation of the new office, NOAA Administrator Richard A. Frank reaffirmed NOAA's commitment "to provide opportunity, equally, for everyone, and to seek the participation of less represented groups in our organization."

A native of Wilmington, Del., Jackson received an A.B. in Biology from Boston University in 1952, and a Master's in Social Work from Howard University, Washington, D.C. in 1956.

She was project director of Neighborhood Service Centers, Greater Wilmington Development Council, Inc., a private non-profit group, from 1967 until 1969 when she became Special Assistant for Human Affairs to the Governor of Delaware. From 1973 until her appointment at NOAA, she was an Equal Employment Opportunity Regional Manager at the Department of Health, Education, and Welfare in Philadelphia, administering the Regional Equal Employment Opportunity Program.

A member of the American Society for Public Administration and of the International Personnel Management Association, Jackson has received several awards for her work in civil rights. Among them are the Business and Professional Women's Woman of the Year, 1969; Delaware's Young Woman of the Year, 1970; Delaware Governor's Humanitarian Award, 1972; and, Delaware's National Conference of Christians and Jews Annual Award, 1977.

Buoys Ride The Ferris Wheel In Tests

The 40-foot ferris wheel at Marshall Hall (Md.) Amusement Park was used this summer to test six buoys designed to monitor wave conditions along the Delaware and Maryland coasts.

The National Ocean Survey will deploy three, 2½-foot diameter buoys off the Chesapeake Bay entrance, Delaware Bay entrance, and Ocean City, Md., in water depths up to 70 feet where wave heights may be as large as 40 feet. The circular motion of the ferris wheel at Marshall Hall, which simulates the motion of a floating buoy in large waves, assisted in the calibration of the buoys.

The 300-pound buoys, called waverider buoys, will provide wave information for beach erosion prevention, management and planning, safe and economical design of coastal and offshore structures, wave forecasts to vessels, and the planning of marine operations. The buoys measure wave motion with accelerometers as they move up and down with the waves. The data is radioed to a shore receiving station where it is sent via phone line to a computer at the National Ocean Survey's headquarters in Rockville, Md.

Dr. Marshall P. Earle, project manager for the NOS wave monitoring program, said the buoy calibration consisted of several phases. "First, the electronics of the buoys and the receiving stations to which they transmit are thoroughly checked. Next, each buoy is placed on a special test apparatus which moves the buoy in a manner similar to wave motion. The data transmitted by each buoy is recorded and compared to the known motion of the buoy on the test apparatus.

Five waverider buoys were calibrated this summer on the 40-foot diameter ferris wheel at Marshall Hall, Md. As the ferris wheel rotates, measurements of buoy motion are transmitted to a receiver and tape recorder on the ground.

"In the Laboratory," said Earle, "these tests can only be conducted for simulated wave heights up to four feet. Hence, the buoys were calibrated on a 40-foot diamater ferris wheel at Marshall Hall Amusement Park." The buoy calibration was carried out by the NOS's Test and Evaluation Laboratory. Gene Russin is the project manager for the calibration part of the NOS program.

noaa/update

HCMM Data Studied By NESS Group

Three scientists from the Environmental Sciences Group, NESS, are evaluating the use of data from a recently-launched NASA satellite in estuarine water circulation studies, soil moisture measurements, and snow thermal properties studies.

Principal investigator Donald R. Wiesnet, assisted by Dr. David F. McGinnis and Michael Matson, will compare data from the Heat Capacity Mapping Mission (HCMM) satellite — launched in April—with ground truth information. The objective is to study the effect of soil moisture changes on thermal radiation; to monitor estuarine tidal currents; and, to study thermal radiation from snow.

Donald R. Wiesnet

The NESS team's work is supported by a grant from NASA. The studies of snow thermal properties are being conducted through a cooperative arrangement with the State University of New York, Syracuse.

Severe Storm Research Aided By New Institute At Univ. of OKla.

A cooperative institute linking the University of Oklahoma and NOAA's Environmental Research Laboratories has been established at the university campus in Norman, Okla.

The newly created Cooperative Institute for Mesoscale Meteorological Studies will promote research on mesoscale atmospheric systems associated with a wide variety of severe environmental storms, short-range weather prediction problems, and meteorological phenomena of the Great Plains.

The Institute's activities will complement research efforts at NOAA's National Severe Storms Laboratory at Norman and other laboratories of NOAA and the university. Scientists from institutions throughout the world will be named visiting fellows at the Institute, collaborating with scientists from the University of Oklahoma and the National Severe Storms Laboratory.

Crop-Drought Study Gets Aid From NOAA Scientists

NOAA scientists have helped agriculture experts in Nebraska study crops' resistance to drought.

The Nebraska study was part of an effort that will eventually take the NOAA researchers all over the Great Plains, from Southern Texas to Montana, says Dr. Bradford R. Bean of NOAA's Office of Weather Modification.

From the instrumented aircraft, Aeolus, the scientific group measure evaporation rates over different crops to help agriculture experiment station experts calibrate their evaporation measuring instruments.

Evaporation and transpiration—loss of moisture through a plant's "exhalations"—are major stresses on crops during their maturing stage, says Bean. "Just when a crop needs water most to mature, it is August, and hot and dry." The Great Plains Council, a conglomerate of agriculture experiment stations, plans a joint study of evaporation from crops. But they need a way to intercompare their instruments, so that results from different stations will be consistent. This is where Bean and his colleagues, Richard Gilmer and Raymond McGavin, come in. Flying over the fields of Nebraska, the NOAA group made evaporation measurements to compare with ground-based measurements made by the University of Nebraska researchers.

The agricultural experiment stations use a device called a lysimeter, a type of scale that is set into a field, beneath a section of the crop-bearing soil that is about 10 feet (3 meters) square and five feet (1.5 meters) deep. The technique consists, basically, of measuring evaporation rates by weighing the soil over a period of time. A weight loss would be attributed to loss of moisture by evaporation or transpiration.

The NOAA researchers also hope to learn something for their own weather modification research. A major project that NOAA plans, called PACE (for Precipitation Augmentation for Crops Experiment) will determine whether cloud seeding can be used to increase the rainfall available to America's corn and soybean belt.

Wind-Sensing Radar Tested

Preliminary tests of a new airborne wind-sensing radar system have been encouraging, say scientists Bob Trotter of the Office of Weather Modification and Dick Stauch of the Wave Propagation Laboratory, developers of the system. The radar, to be installed on NOAA's WP-3d Orion flying laboratories, can measure the velocity of winds along its line of sight with an accuracy of ±2 meters per second.

Progress on the NOAA Airborne Doppler Radar Development Program was reviewed at a meeting in Boulder. The meeting was attended by representatives of ERL, the Federal Aviation Administration, Air Transport Association, major airlines, radar manufacturers, and the National Center for Atmospheric Research.

So far, four flight tests, partially funded by the FAA, have been conducted. The two researchers have given the radar some unique features, including a power amplifier for transmitting the signal that is less expensive than the one used in most doppler radars. The two say it is the only know airborne doppler radar being developed for meteorological research, and those in attendance at the Boulder meeting believe it will also provide a basis for equipment to improve safety of commercial airlines.

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